

A

0  
0  
0  
6  
0  
0  
1  
2  
8  
3



000006001283





C 14

9379

248 | 750

LOUIS SHELDON NEWTON  
ARCHITECT  
HARTFORD VERMONT





**Works of VICTOR T. WILSON**

PUBLISHED BY

**JOHN WILEY & SONS.**

---

**Free-Hand Perspective.**

For Use in Manual Training Schools and Colleges.  
By Victor T. Wilson. 8vo, xii + 257 pages, 139 figures.  
Cloth, \$2 50.

**Free-Hand Lettering.**

Being a Treatise on Plain Lettering from the Practical Standpoint for Use in Engineering Schools and Colleges 8vo, 105 pages, 23 full-page plates. Cloth, \$1.00.



# FREE-HAND LETTERING.

BEING

*A TREATISE ON PLAIN LETTERING FROM .  
THE PRACTICAL STANDPOINT FOR USE  
IN ENGINEERING SCHOOLS  
AND COLLEGES.*

BY  
VICTOR T. WILSON, M.E.,  
*Author of Free-Hand Perspective.*

*FIRST EDITION.*  
FOURTH THOUSAND.

NEW YORK :  
JOHN WILEY & SONS.  
LONDON : CHAPMAN & HALL, LIMITED.

1905

SK

Copyright, 1903,  
BY  
VICTOR T. WILSON.

ROBERT DRUMMOND, PRINTER, NEW YORK.

## PREFACE.

---

THE student who takes up the study of lettering, as outlined in these pages, will not find it to consist of a set of copies which if reproduced carefully will give proficiency in the subject; copy work seldom yields more than a meaningless result, it does not lead to independent and creative work. Erroneous conceptions have grown out of the idea that letters are standard, that they are rigidly fixed in their forms; the truth is there are no really fixed forms. Variety will be found to some degree in all lettering; each line of it the draftsman makes is creative work.

Nor should he who undertakes the study be encouraged to think that a few hours of labor will develop proficiency. It is not an easy task, long and patient labor rightly directed will alone give that certainty of touch and judgment of values which are necessary. The student is dealing with forms having a character which can be spoiled, while apparently departing but little from the fundamental type, and which, on the other hand, can be treated with an almost infinite and

subtle variation without detracting from the result if done in the right way.

Without a measurable knowledge of free-hand drawing, wherein is derived accuracy of hand and eye and an intelligent sense of proportion, it will be found impossible, beyond the merely imitative, to do good work. The author has endeavored to treat the subject with this in view. Emphasis is laid upon attaining a proper attitude, through the development of a letter, a word or line of words by a sketch method, analogous to that used in other free-hand drawing. It is the object to cultivate the conception that all lettering is design, that any mathematical or mechanical attempt at treatment is entirely impracticable in ordinary work. Emphasis is also laid upon attaining facility in the free single-stroke letter used on working drawings, by a careful analysis of the stroking and by practical points about the handling of the pen and a description and an illustration of a variety of styles from which to choose.

The chapter upon the design of letters, which it is hoped will afford matter of interest to the thoughtful student, is not intended to form part of a regular course of study, but is for occasional reference only. It is a phase of the subject either overlooked or but slightly touched upon in books on lettering.

Attention is called to the footnotes added to a number of the plates, summarizing the chief points to be noted about them, also to the references printed under each plate, covering all the places in which each is discussed

in the text. It is hoped that this will be found a convenience in using the book for reference.

A number of authorities have been consulted in the preparation of the work, among them Prof. Henry S. Jacoby's book on "Plain Lettering," an excellent treatise; J. C. L. Fish's "Lettering of Working Drawings," containing some good practical offhand styles; "A Practical System of Offhand Lettering," by Chas. W. Reinhardt, also notable in its treatment of offhand styles and in the analysis of the stroking for the same; Frank C. Brown's "Letters and Lettering," probably the most artistic treatment of letters which has appeared up to the present time: from these the author has taken the liberty occasionally to quote. His thanks are also due to Messrs. Chas. Scribner & Sons for permission to copy some styles from the recent treatise of Lewis F. Day, "Alphabets, Old and New," and which constitutes the matter on Plate XXI.

VICTOR T. WILSON.



# TABLE OF CONTENTS.

---

	PAGE
PREFACE, . . . . .	iii

## CHAPTER I.

### THE CONSTRUCTION OF ROMAN AND GOTHIC LETTERS.

1. Good Lettering is not Mechanical, but is Good Design. . . . .	1
2. Illustrative Example. . . . .	4
3. Brief History of the Roman and Gothic Letters. . . . .	7
4. The Roman Letter. . . . .	9
5. Variations in the Different Letters. . . . .	11
6. The Roman Letter is not a Fixed Type. . . . .	13
7. Further Analysis of the Roman Letters. . . . .	14
8. Analysis of the Small Letters. . . . .	18
9. The Roman Numerals. . . . .	19
10. Proportions of the Roman Letters Vary. . . . .	20
11. The Gothic Letter. . . . .	22
12. Analysis of the Gothic Capitals. . . . .	22
13. Analysis of the Small Letters and Numerals. . . . .	23
14. Italicized Roman and Gothic Letters. . . . .	24
15. Stump Writing. . . . .	25
16. The Proper Ratio of Small Letters to Capitals. . . . .	26

## CHAPTER II.

### SPACING.

17. Spacing is a Problem in Design. . . . .	28
18. Spacing Depends upon Several Variables. . . . .	28
19. Illustrative Example. . . . .	29

	PAGE
20. Development of Proper Space by Sketch Method.....	32
21. Sketching Preliminarily in Outline Gothic.....	34
22. Spacing of Words, Punctuation, etc.....	35

## CHAPTER III.

## THE USE OF THE PEN AND OFFHAND LETTERING.

23. Letters Should be Drawn Throughout, not Copied.....	37
24. The Kind of Pen to Use.....	38
25. The Kind of Ink to Use.....	40
26. The Kind of Paper to Use.....	40
27. How to Handle the Pen for Offhand Lettering.....	41
28. The Outline Gothic for Offhand Work.....	44
29. Other Offhand Styles.....	46
30. Some Special Directions about the Use of the Pen.....	50
31. Proper Size for Offhand Lettering.....	52

## CHAPTER IV.

## DESIGN OF LINES AND OF TITLES.

32. The Single-line Title.....	54
33. The Choice of Style and Size.....	55
34. How to Lay Out the Line.....	57
35. Degree of Finish to Give a Title.....	58
36. The Design of Grouped Titles.....	59
37. Various Considerations to be Observed in Designing.....	60
38. Example of How to Lay Out and Execute the Design.....	62
39. A Title may be Variously Treated.....	64

## CHAPTER V.

## LETTERING FOR VARIOUS TECHNICAL PURPOSES, INCLUDING PHOTO-REPRODUCTION.

40. General Statement.....	66
41. Lettering on Maps.....	66
42. Architect's Lettering.....	68
43. Lettering on Working Drawings for Manufacturing.....	69
44. Lettering for Photo-reproduction.....	71
45. Lettering for Patent Office Drawing.....	74
46. Lettering for Advertising Purposes.....	75



## CHAPTER VI.

## THE DESIGN OF LETTERING.

	PAGE
47. General Statement.....	79
48. Single-stroke Gothic may be Taken as the Basis for all Design. ....	80
49. The Preservation of Type Style.....	81
50. The Old Roman Letter.....	83
51. The Effect of Changing Proportions and Spacing.....	84
52. Other Considerations in Design.....	85
53. Open- and Closed-body Letters .....	87
54. The Limitations of Letters.....	88

## CHAPTER VII.

## MECHANICAL AIDS TO LETTERING.

55. General Statement.....	91
56. Practical Points about Executing a Ruled Letter.....	92
57. Drafting-room Practice in the Use of Stock Titles Reproduced in Blue-prints, etc.....	93
58. Lettering Triangles.....	94

## LIST OF FULL-PAGE PLATES.

---

- I. Modern Roman Capitals Analyzed.
- II. Modern Gothic Capitals Analyzed.
- III. Modern Roman and Gothic Small Letters and Numerals Analyzed.
- IV. Roman and Gothic Capitals and Small Letters and Numerals Italicized.
- V. Stump Writing and Single-line Gothic.
- VI. Illustrations of Roman and Gothic Letters Formed into Words.
- VII. Illustrations of Spacing.
- VIII. Single-stroke Upright Gothic and its Variations for Working Drawings.
- IX. Various Offhand Styles for Working Drawings and Illustrations Showing their Application.
- X. A Working Drawing Title Shown in Various Stages of Sketch Development.
- XI. A Working-drawing Title Treated in a Variety of Ways.
- XII. A Working Drawing Showing the Application of Offhand Lettering and Dimension Figures.
- XIII. Titles on Working Drawings Taken from Original Sources.
- XIV. Titles on Working Drawings Taken from Original Sources.
- XV. Letters Authorized by the U. S. Geological Survey.
- XVI. Letters and Conventions Authorized by the U. S. Geological Survey.
- XVII. Alphabets Suitable for Architectural Drawings.
- XVIII. Architectural Titles.
- XIX. Illustrations of the Effects of Photo-reproduction.
- XX. Illustrations of Advertising Lettering.
- XXI. Various Designed Letters.
- XXII. Modern Roman-Gothic Alphabet of Capitals and Small Letters and Numerals.
- XXIII. Old Roman Alphabet of Capitals and Small Letters.

# FREE-HAND LETTERING.

---

## CHAPTER I.

### THE CONSTRUCTION OF ROMAN AND GOTHIC LETTERS.

#### **1. Good Lettering is not Mechanical, but is Good Design.**

The lettering which the draftsman in practice is called upon most frequently to make consists of a rapidly executed statement, upon a drawing, descriptive or otherwise; the style most suitable, therefore, is a simple one which through practice he learns to do readily. Now and then a design of a group of lettering is called for, such as we find in the titles to working drawings, but more frequently even this is very plain and executed in some one style throughout.

The beginner is apt to approach the subject with the misconception that lettering is a form of mechanical drawing, that the use of the straight-edge is in order, that the various letter forms and the spaces between them can be figured out by measurement; unfortunately books on lettering have been apt to encourage this misconception by containing large alphabets, very

rigidly analyzed as to proportions, etc., with little explanatory matter attached, so that the impression is left that mathematical exactness is most important. In this respect, ordinary **printed lettering from type is not an instance of good lettering**, for the forms come together as best they may and do not produce a uniform result. This lack of harmony can easily be detected by any one who has keen perceptions; it is easy to discern, for example, whether or not, in certain advertisements that come under our notice daily, the Roman and Gothic letters are set up in type or reproduced from an original drawing.

Fundamentally **good lettering will be good design**. Just as the designer of fabrics or wall-paper takes his forms and distributes them over prearranged spaces in a *uniform and pleasing manner*, so the letterer takes his more rigid forms, his letters, and distributes them uniformly in his prearranged spaces so as to give a combination pleasing to the eye.

Good design in lettering requires first that we have **simplicity in style**. There are no more striking instances of good lettering than are to be found on the bill-board, street-car and other advertising. If the student will take the trouble to investigate, he will find that the letters used most frequently are the simple Roman or Gothic, more often the latter (see Plates I and II).

The second requisite in good lettering is **uniformity in the effect**. This can be explained best by taking a line of lettering as an illustration—line 5, let us say, on

Plate VI . The separate letters should appear to be of the same height, the same size, and the spaces should also appear to be uniform, not to mention that each letter must be of the same alphabet style. Both considerations, simplicity of style and uniformity of treatment, are accomplished through the aid of judgment and taste, combined with accuracy of hand and eye in the detection of small differences. To be sure letter forms are somewhat, although not entirely, standard. No rules can be followed which are practical and which will invariably produce the same result with all forms in various combinations, notwithstanding that books on the subject strive to find rules to cover all cases. They are largely unsuccessful because they lead to dependence upon measurement instead of upon the unaided eye.

A knowledge of free-hand drawing is essential to facility in lettering because the eye is then trained to see form and to judge of effects; moreover, lettering to be skillfully done should be treated much as a free-hand drawing is treated, that is, the more finished kind, by a step-by-step process which deals first with the broad simple effect and proceeds to the details gradually in the order of their importance. To use a concrete and extremely simple illustration: The development of a letter should proceed in a method similar to that in which we should draw a straight line between two given points; the first thing to do is to get a sense of direction between the points by passing the hand to and fro and indicating it by a few tentative strokes here

and there; these can be added to by others, connecting them, the whole being not a line but a series of more or less connected and overlapping marks giving general direction; this can be refined by repeating the process, working in a more and more restricted area until the line assumes as much exactness as desired or that the draftsman is capable of attaining. **The treatment of the line is typical of the process in any free-hand drawing no matter how complicated; the motive comes first and the details afterwards.** An isolated letter should be drawn in this way; in the same way a word or line of words, or a combination of lines and styles.

## 2. Illustrative Example.

Let it be required to draw a few large isolated letters of the Gothic style shown on Plate II. **Fig. 1** illustrates the step-by-step process of developing the letters. They are to be taken singly. The several stages, moreover, from *a* to *g* must be considered as purely arbitrary; whether the letters are carried through these or a greater or less number of stages will depend upon the judgment or the skill of the draftsman. The chief thing to note is that the development in each case is so handled that *but one phase of it is treated at a time*, the largest feature first and the **smallest details last**. The **first and most important feature is proportion**; this is indicated in *a*; a suggestion only of the form is next given in *b*, as well as a refinement of the proportions showing more definitely the maximum spaces the letters occupy.

Fig. I.



A more complete shape to each letter is given at *c*; after this at *d* a suggestion of the **weight of body is added**. Uniform weight is insured by paying attention to scaling the thickness only in scattered places. In *e* the letter shows further refinement of form and weight, while we have the final careful outline in *f*.

The line *g* is introduced to show incidentally how the heavy body of the letter may be put in in ink, itself shown in three stages. First a strong wall of ink is put around the inside of the outline, then if the letter has a very heavy body, intermediate strokes may be introduced as in the B. This development is analogous to the method used in any free-hand drawing.

If the Roman letter form were the subject of such an exercise it would be perfectly feasible to carry it through the first three stages *a*, *b*, and *c*, in the same treatment as employed for the Gothic letter; a stage analogous to *d* might begin to indicate the characteristic style of the letter, and the remaining stages to the development of it.

The advantage of this comprehensive treatment of the drawing, as it may be called, is, as briefly stated above, that the essential facts are treated first and as each new feature is taken up it allows the draftsman to see and correct his errors as they develop.

The only place for mechanical treatment in ordinary lettering is in making the limiting lines; even the skillful draftsman will do this except in very small work;



certainly the beginner should *never fail* to rule at least *two*, if not more, limiting lines for all letters.

### 3. Brief History of the Roman and Gothic Letters.

The uninitiated are apt to think that type as we have it now from the foundry in the simple pure Roman and Gothic styles is a fixed letter having some authoritative claim to being standard. It represents, however, only a stage in the growth of forms more or less variable, and some intelligent understanding of the reasons for this will help the student in arriving at a proper attitude towards lettering in general.

It is generally believed, although it cannot be proved, that the **alphabet is of hieroglyphic and Egyptain origin**; the oldest manuscripts left to us come from Egypt and date back many centuries B.C. The hieroglyphic characters express ideas, later such characters become symbols of single sounds, and it is from these we get the alphabet and letter forms.

In the earliest four or five centuries of the Christian era there were two distinct hands visible in the manuscripts, one the **majuscule**, analogous to our capitals, and the other the **cursive or running hand**. Throughout the centuries these hands reacted upon one another, each becoming modified through the influence of the other, and later they formed the basis for type. Of course the invention of printing soon put an end to the systematic work of scribes, although such writing still survived for a long time for choice works. **The first**

**printed books** appeared about 1450 A.D. and were made in Germany; imitating as they did the hand of the scribes of the fifteenth century in that country, they naturally partook of the heavy black-faced letters then prevalent. The early Roman types were in imitation of the Caroline minuscule, prevalent about the ninth to the eleventh century, and which from that on became universal in Latin Christendom.

In the early Roman we also see distinct evidences, in the thick and thin lines, of the **imitation of the strokes of the quill** used by the early scribes—the reed was not in use in Western Europe later than the early part of the sixth century, when it gave place to the quill. The stiff-nibbed quill used by these early scribes was held nearly perpendicularly to the paper, but inclined to the line of the writing. The down strokes were made heavy, including the inclined ones in the M, W, N, etc. The letters are characteristically square, and although the present letters vary somewhat from the original, their skeleton is *still based upon the square form*. The Gothic, unlike the Roman, never reached an authoritative form; every letter has a variety of shapes, any one allowable so long as it expresses the characteristics of the style, which is mainly that of a uniform body letter.

It is interesting to note, in this connection, that hand-writing, although the parent of the first type forms, was forsaken by its offspring, which grew independently and steadily in the effort to arrive at a fixed legible form; **handwriting**, on the other hand, shows varied phases of

**growth and decay;** forms were gradually developed and a "universal hand of the day" was evolved; then, through various causes, decay took place, writing becoming more illegible until, through a reform movement, type forms are imitated. We can note this to-day in the upright and round handwriting succeeding Spencerian.

Small letters were not in evidence in the early manuscripts; they came in gradually and long after the capital forms, becoming fixed, however, by the ninth century. The broad capital letter, known as the Rustic, prevailed in the manuscripts of the fourth and fifth centuries; the miniscule only became general by the ninth. This was developed in its most perfect form by the master printers of Venice, and it is to this period of the Renaissance in Italy that we turn for the best examples of these forms. The scholars and printers of this period took as their models the pure Caroline forms of the old manuscripts, and the Roman letters used by them have not varied appreciably since.

Thus we see that letters have gone through **stages of evolution like other forms**, and to-day we have letters which, while more or less apparently rigid, are yet capable of a certain variety under the fancy of the designer, who is free to devise new forms as he was in earlier days; this is in fact being constantly done.

#### **4. The Roman Letter.**

The alphabet most familiar to-day is the Roman, but for the draftsman, partly because it is so familiar to

every one and therefore calls for a higher degree of accuracy, it is the most difficult to execute acceptably, and hence is little used by any but the most expert; were it not so difficult it would undoubtedly be used more. The Gothic is much simpler and is used most commonly by the rank and file of draftsmen; however, it is essential to an adequate knowledge of lettering that the Roman be understood, therefore we will investigate it first.

Plate I shows the alphabet of capitals, called by the printer **upper case** because these characters lie in the upper and less accessible part of the type-case as it stands inclined in front of him. Plate III shows the small letters of this style and the numerals; the first are called **lower case** because in type they lie nearest the printer's hand in the lower part of the type-case, since they are more frequently used. The small letters are scaled to go with the capitals, but the numerals, for convenience, are drawn to a different scale.

On Plate I the *letters vary in size*, both as to width and in a few cases as to height, in order to convey an impression of uniformity. The letter which may be taken as a *standard of reference*, and called of normal size for convenience, is the **H**; it occupies the full rectangle of space allotted to it.

The proportion of the letters in these first two alphabets is that in common use, and this, for want of a better distinguishing term, we will call standard. The height of the letters is, for convenience, divided into six equal

parts, and the widths are scaled and designated by units of the value of one of these divisions; for example, the **H** is five units wide and six units high. However, it must be understood that the letters have no fixed proportion; this is to be particularly noticed in the artist's free designed alphabets (see Plate XXI). The letters may take an infinite variety of shapes, weight of body, etc., within certain not easily defined limits. **The term standard proportions is purely an arbitrary term**, chosen for convenience, and is applied to our present type-letter. Some style of letter should have careful analysis by the student, and this is chosen for the purpose.

## 5. Variations in the Different Letters.

The letters will vary in width because those which do not fill their rectangle of space, as the **H** does, would look smaller in size than the **H** if made of the same width; to preserve uniformity of effect they must be made slightly wider than the normal letter. For example, the letter **A** must be spread out at the base because it only occupies half of the rectangle of space allotted to it; likewise the **B**, **C**, **D**, etc., must be widened somewhat, each to a different degree. The **O** and **Q** are widened most because they only touch by tangency the rectangular limits.

The letters will vary in height, because where a letter touches its upper and lower limits only by tangency it would look shorter than the **H** if it actually were made tangent to them; it must be made slightly taller, in

fact must exceed both upper and lower limiting lines; among these we have the **C**, **G**, and **O**. Letters such as **A** and **V**, etc., would also have to exceed the limits if their angles are made sharp; to overcome this they are, in the plate, shown somewhat blunted; this practice is not universal, however.

The exceptions to the above are the **L** and the **F**, which are made narrower than normal because of their shape, having in each case a vertical stem and one horizontal member. To make them really of normal width in a line of lettering causes them to seem to be spread out too much, so they are actually narrowed somewhat, the **L** most, because it has no horizontal member in the middle to help fill up the space as has the **F**.

**The letters are further modified to produce an effect of stability;** that is, those letters which have distinct upper and lower parts will appear more stable and of good form if the lower section is made larger than the upper; for example, the lower lobe of the **B**, the two lower arms of the **X**, the lower leg of the **K**, the lower horizontal stroke of the **E** and the **Z**; the lower curve of the **S** also is larger across and higher than the upper. If difficulty is experienced in feeling the force of these variations, drawing out a few, in one case ignoring and in another taking account of them, will doubtless serve to make the defects apparent.

**The letters vary in their several variations;** that is, when combined together to form words it will be found that slight modifications in size can be introduced here

and there to advantage; for example, an **L** just preceding an **A** can be made narrower than if it were followed by an **H** or were itself at the end of a line or a word.

The amounts of the several variations of letters, as they are recorded on the plate, should not be regarded by the student as having any significance further than to call attention to their existence relatively and to aid in forming a correct perception of variations. They should not be considered as measurable quantities; different proportions of letters would call for variations in the degree of these variations. In practice the eye should be cultivated to estimate the amount of variation necessary; indeed this will be found indispensable in practice, where the small size of the lettering often done will preclude any calculation and where time may also be an important factor. To burden the mind with **figuring out variations** will result in **spoiling the spontaneity of design**. In the very small lettering which is quite common, say letters of a height of an eighth of an inch up to three eighths, the variations, although necessary in a small degree, are entirely incommensurable.

## **6. The Roman Letter is not a Fixed Type.**

The Roman alphabet is not a fixed type in which exact proportioning of parts is attainable. The ancestors of this letter had a very different form from that which we now find in the printer's type or in modern good examples. They have been modified and changed by

different authorities. We cannot point to any one illustration of a perfectly correct Roman type, but to many, varying slightly in some cases, quite radically in others. Prof. Jacoby says:\* “The modern form is the result of modifications mainly introduced in the eighteenth century by some English type-founders.”

Variations are evident in the widths of letters, the size and shape of the serifs, in the relation between the light and heavy strokes, together with some changes in particular letters, the length of the middle bar of the **E** and **F**, the shape of the lower jaw of the **G**, the inclination of the legs of the **K**, sharpness of the points of the **A**, **V**, **M**, etc.; even such a radical change is attempted as making the **O** forms not true ellipses, but ovals with the widest part slightly above the middle of the letter.

## 7. Further Analysis of the Roman Letters.

The heavy stems of the letters are made a normal width of one unit. If the body varies in thickness, as in the **B**, **C**, **G**, etc., the maximum width at the middle is slightly greater than one unit; if it were made exactly one it would look narrower, because this width is not maintained throughout the body, but only at one point.

The **S** and the **U** are exceptions, for in these the curved bodies pass into straight portions for a distance great enough to maintain the effect of uniform weight with the rest of the letters.

---

\*“Plain Lettering,” by Prof. Henry S. Jacoby; pub. by the Engineering News Pub. Co.



The serifs are made three-quarters of a unit wide and of a thickness of the light stems; they are joined to the vertical stems by a tangent curve, the quadrant of a circle of half a unit radius; where the serifs join oblique stems these arcs become elongated, still however, being tangent to the serif and to the stem. The serifs can be varied, to a degree, in their width, and their relation to the width of the heavy body also changed, to suit the fancy of the designer.

It is interesting to note that if the form of the curve connecting the serif to the stem is elongated vertically to be tangent to the middle of the height of the stems, we have a very different letter from the Roman, but one which is quite a common form of ornamental letter (see Fig. 9).

The serifs are here made of the same width at the top and at the bottom, but in the case of large letters it will conform to good design to make the **upper serifs narrower**, by a very small amount, than the lower ones.

The large spurs on the **E, F, L, T, and Z** do not join the body of the letter like the serifs, by tangent curves; the uniting curves meet the horizontal strokes abruptly. If the letters were to be very much widened, the spurs would look better if made to approach them by tangency.

The mid-horizontal strokes of the **B, E, F, H, and R** are put slightly above the center of the space; if they were put at the exact center, the effect made upon the observer would be that they were below. Try it with a few letters constructed both ways. The **P** is an excep-

tion to this, for otherwise its upper part would look dwarfed.

To preserve an effect of stability, the lower part of the **B**, **E**, **K**, and **R** extend slightly farther to the right than the upper part; for similar reasons the legs of the **X** cross above the center of the space, and the lower curve of the **S** is made larger than the upper. Turn the plate upside down and note the amount of these differences.

The inner and the outer edge of the curved part of letters, as **B**, **C**, **O**, **P**, and the upper part of the **R**, are formed by arcs of regular closed curves with vertical and horizontal axes; the inner ones approach the outer tangentially. If the letters were proportioned very wide they might meet them abruptly, but the form shown on the plate is the one most common; on the plate, also, the vertical axes of the outer curves are slightly larger than their horizontal ones except the **U**. Note that in the case of the **C**, **G**, **O**, **Q**, etc., the inner curves are tangent to the outer slightly to the right and left of the vertical axes of the latter.

The curved forms are apt to give the most trouble in drawing, but much of the usual difficulty may be avoided by following a sketch method, previously outlined, for their development. A very brief indication of form should receive first attention, with chief emphasis upon symmetry and without necessarily a careful clean line; next, a more complete suggestion of form may be given by connecting up the sketch-strokes into a somewhat

continuous curve, and so by degrees, following the same step-by-step process, filling in between the disconnected strokes and refining the symmetry and balance of the form, the careful clean line of the finished curve may be developed substantially as lines are developed in a free-hand drawing.

The **R** and **S** need some especial comment. The general tendency of the tail of the **R** should be outward towards the foot of the letter as opposed to vertical; perhaps a safe guide in drawing it, whatever the proportions of letter adopted, would be to see first that a tangent to the outer curve at its point of changing curvature is very slightly inclined from the vertical, and then to make the inner curve harmonize with the outer.

The compound curve which comprises the **S** is apt to give trouble, but this may be somewhat lessened by using an **O** of the same proportions as a basis in sketching; however the upper and lower parts of the curve of the **S** are not duplicates of the corresponding parts of the **O**; they are flatter and the necessary modifications must be introduced in finishing. If a single-stroke letter is needed as a basis, note that the point of changing curvature is in the **center laterally**, but **slightly above the center vertically**. The inclination of a tangent which might be drawn at this point would depend entirely upon the proportions of the letter dealt with; it would approach a horizontal position as the letter is widened, but it should not reach the horizontal in any case, or

much less be inclined downward towards the left, a common fault that may be frequently seen.

## 8. Analysis of the Small Letters.

On Plate III are the small letters drawn to harmonize with the capitals. The small letters may be divided into three classes: **ascending**, **descending**, and **short letters**. The ascending, except the *t*, have a height equal to the capitals, and the descending are the same in total length. The height of the short letters relative to the others is not fixed; authorities differ as to the best proportions, but they usually vary between about **one-half and two-thirds the height of the capitals**. Prof. Jacoby recommends six-tenths, a quantity approximating the value obtained by using the '*golden cut*,' which he describes fully in his book on "Plain Lettering." In large lettering the designer should let proportion, weight of body, requisite prominence, etc., be the deciding factors in settling upon this ratio. Those on the plate are made six-tenths of the height of the capitals.

The width and height of the small letters are related to each other in the same manner as the corresponding dimensions of the capitals. The height of the short letters is divided into six equal parts, and one of these is used as a unit both for width and weight of body. A *u*, *n*, or lower part of the *h* is taken as a standard letter, and the others are made to conform to it. The same peculiarities as to variations which

occur in the capitals occur also in the small letters.

Two forms of **a** are shown; the first may be considered the standard form.

The **g** is a letter which will probably afford considerable difficulty in construction; if treated in a manner analogous to that suggested for the capital **S**, the difficulty will be lessened; that is, construct the upper and lower regular closed curves first and separately and then connect them by the small curve which is tangent to the *lower but not to the upper* oval.

The **o**, **s**, **v**, **w**, **x**, and **z** are miniatures of their respective capitals in every respect.

## 9. The Roman Numerals.

The Roman numerals are shown at the bottom of Plate III. They are made shorter and narrower, for want of space, than they should be to harmonize with the capitals on Plate I. Their width is lessened by taking as a unit one-sixth of the height of the short letters instead of one-sixth of the height of the capitals, which would be the proper procedure in practice. General custom seems to call for a numeral the height of the capitals, but slightly narrower; some consider that they should be shorter than the capitals, let us say by about one unit, where capitals and small letters are together used. There is good ground for this contention, for by contrast with the small letters the numerals are apt to appear too large if they are made as tall as the capitals.

Some lines of letters illustrating this point are shown on Plate VI.

The numerals have the same peculiarities as to variations in width, height, and weight of body that the letters do. It is well to draw the round forms by sketching an ellipse or **O** as a basis the same as for the **S**.

An alternative form for the base of the **2** and one for the top of the **5** are suggested below and above the respective figures. Of the two forms of **3** shown, the first is the standard, although it is more difficult of construction.

The skeleton of the **3** consists of two regular ovals tangent to each other a little above the middle of the figure and having vertical and horizontal axes.

The **8** is also based on the same construction.

The **6** and **9** are duplicates of one another reversed in position. The inside curve in each of the curved forms is also, like the curves in the capitals, a regular oval of different proportions from the outer one, but having the same axes.

## **10. Proportions of the Roman Letters Vary.**

Proportions of any letters, whether Roman or not, can of course vary according to the lettering to be done in any given space. The normal width of the letters on the plate is 5 and the height 6; desirable proportions for common use would lie between this ratio and the ratio of 4 to 6.

With a variation of width, the weight of stem may

vary independently; the latter, for equal legibility, will vary less than the former.

The lighter stems if increased up to a certain point of thickness, relative to the heavy stems, change the character of the letter, and omitting the serifs we have what is known as a **Roman-Gothic form** (see Plate XXII).

Fig. 2.



The effect of changing the widths of the Roman letters, and also the weight of body, is shown in **Fig. 2**. All of the letters are of the same height; line **a**, **c**, and **e** are each of different widths of letter with a proportionate increase of thickness of heavy stem; lines **b**, **d**, and **f** show the same width of letters as the preceding lines

respectively, but have a body one and one-half times as heavy.

The letters in line **c** are like those shown on Plate I.

The limits either way of narrowing or widening are simply those controlling legibility.

## **11. The Gothic Letter.**

Plates I and III show the Gothic capitals and small letters; they are much easier to make than the Roman and are a very common form in practical lettering both as a heavy body and as a single-stroke letter; the student should give the preference to it and study it carefully.

The proportions shown are the same as those in the Roman letter except that the weight of the stem is reduced to three-quarters of a unit on account of its uniform thickness. It is to be observed that weight of stem, as influencing variations in width, is here illustrated. The light stroke on the outside of some of the Roman letters causes a different effect in the total width of letters from what it would were it heavy. In the Gothic alphabet, for this reason, the **A, N, R, U, V, W, X, and Y** are made wider at the base than the corresponding Roman letters.

## **12. Analysis of the Gothic Capitals.**

This is an alphabet of **uniform thickness of body**. The ends of the members of the letters, when heavy bodies are used, are cut off perpendicularly. The **C, J, S**, etc., are frequently ended by horizontal limits, but it is not good standard construction.



An alphabet similar to this one is often used, namely, the **block letter**, consisting entirely of straight lines; the curved forms are turned into rectangles with the corners cut at angles of  $45^{\circ}$ . At best, however, it is an awkward and mechanical letter, a poor substitute for the Gothic. It were better to substitute a free offhand letter such as is described in Chapter III for the Gothic, if the latter in its curved forms is found to be too difficult.

The construction of the Gothic letters parallels the Roman in all but a few particulars.

Note that the upper angles of the **M** and **N** are as wide across as the body of the letter. The lower angle of the **N** is also as wide as the stem, but that of the **M**, **V**, and **W** is cut off, so as to make a sharp limit to the forms, a broader base relatively than the Roman letters have. The **V** is like the **A** reversed and has the same sharpness of apex; the upper vertex of the angle of the **W** is slightly sharper than the two lower ones.

The tail of the **R** is different in curvature from that of the Roman, coming as it does squarely to the limiting line. Several different forms of this are also to be found; one curves tangent to the limiting line, ending in a vertical edge at the point of tangency, or an inclined edge slightly beyond it, and another form is straight at the lower part, with only one short curve where it joins the upper part.

### 13. Analysis of the Small Letters and Numerals.

The small letters and numerals are shown on Plate III.

The same fraction of the width of the normal letter, **n** or **h**, as in the capitals, is taken as the unit of thickness of body; the proportions are otherwise scaled as in the Roman small letters. No special comment on the forms other than those given for the Roman are necessary, except to note the following: In letters like **a**, **b**, **d**, **h**, etc., where one part of the body meets another part it will be by entire tangency of the one with the other, so that the thickness where the two overlap is equal to that of one stem.

The numerals have the same general form as the Roman, and on the plate are not made to correspond with the capitals for the same reason that the Roman numerals were made smaller.

There is another form of **2** which is in common use but is not standard; in it the curved upper part joins the lower by an inclined straight line instead of by a compound curve.

#### **14. Italicized Roman and Gothic Letters.**

Plate IV shows the Roman and Gothic alphabets when italicized. For the sake of variety the proportions of the capitals are changed slightly, being narrowed; those of the small letters remain the same. The numerals are constructed according to the suggestion contained in section 9, namely, somewhat shorter than the capitals.

Italicizing a letter is thought by some to render slight faults less noticeable, and it is probably the truth to some extent, because we are not as familiar with these

combinations of direction as we are with those in the vertical letter.

The **main slant** of the letters may vary between certain limits governed in part by legibility; that shown is a fair average. The bisectors of the angles of letters having inclined sides have the same slant as the main stems of the other letters.

The **slant of the axes** of the **curved forms** differs from this slightly; it may be conceived of as derived from the vertical letter by pulling out at the opposite corners the circumscribing rectangle until it becomes a rhombus or a rhomboid; the curved forms like **O** and **C** will be tangent to the middle of the sides of this parallelogram.

In sketching these letters free-hand, it is a very essential requisite that the slants should be uniform in all stems. To facilitate this, the beginner is advised, if he finds difficulty in estimating it, to rule light parallel lines at random throughout the lines of letters to act as guides for the eye in arriving at the proper slant.

If a Roman upright capital and italicized capital are to be treated in the same line, then for equal weight and proportion the **italicized** should be a **trifle shorter** than the **upright**.

## 15. Stump Writing.

Stump writing, as shown on Plate V, is a form of free inclined letter somewhat similar to the Roman small letters; it is well adapted to offhand lettering. Its chief difference from the Roman small letter lies in the absence

of most of the spurs and serifs and the substitution of curves for the horizontal serifs at the ends of letters; in a line of lettering these do not form connection with neighboring letters, however, but each is separated from the others as in the Roman (see Plate VI). It serves very well where a neat-appearing letter is desired with a minimum of drawing. The proportions, it will be noticed, are the same essentially as the Roman small letters, the chief exception being where the finishing curve is carried beyond the normal limit of the letter, as in the **a, d, h, l, m**, etc.

The capitals to go with this alphabet are the Roman shown on Plate I. The numerals are of a free style and can be used appropriately with these letters; the regular Roman numerals can, of course, also be used.

## 16. The Proper Ratio of Small Letters to Capitals.

In section 8 mention was made of the customary relation between the sizes of small letters to capitals. That the force of the different proportions may be appreciated Plate VI is added. It shows the Roman and Gothic letters formed into words, using these different relations. **Line 1** illustrates the standard or *one to six-tenths*, while **line** <sup>2</sup> is *one to one-half*. **Line 3** illustrates probably a more practical ratio of *two to three*.

The numerals in line 1 are shown the standard of height equal to the capitals, while in the remaining lines they are shown in the more appropriate relation (where

small letters as well as capitals are used), which is about one unit shorter than the capitals. The student is left to study the plate carefully and to feel the force of the different treatments.

## CHAPTER II.

### SPACING.

#### **17. Spacing is a Problem in Design.**

Proper spacing is exceedingly important and, like proportions of letters, is **best obtained by the unaided eye** rather than by adherence to a system or mathematical scale. Some authorities do give ratios for proportioning letters and rules for spacing. These only approximate to truth and good effect and cannot really be depended upon in all cases.

#### **18. Spacing Depends upon Several Variables.**

It is a common fallacy to believe that the clear distance between letters is a constant; it varies. Proper spacing of letters requires variation according to the different combinations of letters, the weight of stems of the different letters combined, and to some extent upon the average space between them. To be specific, it depends upon a due regard to the following:

(a) **Equivalence of area** in spaces bounded by the imaginary upper and lower limiting lines and the sides of adjoining letters; these areas should appear equivalent in all cases.

(b) **The clear distance between letters**, which exercises a modifying effect upon these space areas; the fact, for example, that the **V**, **A**, and **W** spread out at one part more than another, not filling their full rectangle of space.

(c) **The weight of the exterior lines** of letters, which also has a modifying effect upon these space areas. If the exterior lines are light, as in some of the Roman letters, for example the **N**, they will tend to magnify the space between letters over what it seems to be with heavy adjoining stems.

(d) **The average space between letters**, which makes irregularities of spacing less apparent the larger it is. On geographical maps where the space between is two or three times the width of the normal letter, or even greater, sufficient accuracy in spacing is attained by making the distance between the centers of letters a constant, except perhaps in the case of the **M** and **W**.

### 19. Illustrative Example.

Let the rectangle of space between an **H** and an **N** be taken as a basis of comparison. If an **A** succeeds the **H** or any letter which recedes from its rectangle of clear distance, the space between them must be lessened accordingly; the amount of lessening due to this is governed by the way in which the letter recedes. The **L** and **T** are exceptional forms, exposing as they do different spaces between themselves and other letters from those in any other combination. It is quite feasible, therefore, to cut these down in width less even in some

cases than they are in the alphabets on Plates I and II, where they precede letters whose form will suggest too large an intervening space. This may be illustrated by LT, LV, etc.

Fig. 3.

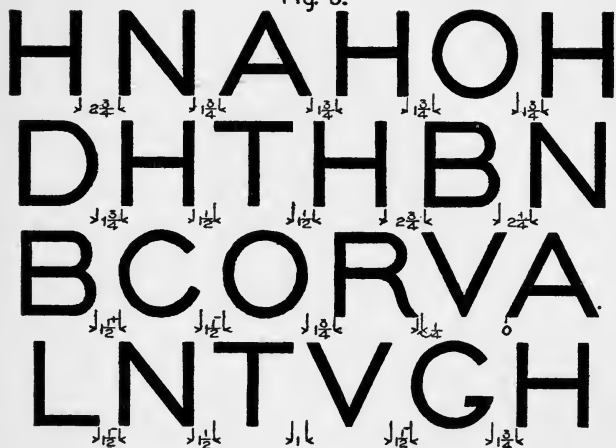


Fig. 3 shows a few lines of letters taken at random to illustrate uniform and harmonious spacing. No rules were applied in making up the figure, only the judgment through the unaided eye, and it is therefore not to be supposed that it cannot be improved upon. It shows very nearly all the different combinations of letters that can occur, sufficient at least to be representative. The numerical values, scaled after the letters were drawn, are in terms of the same unit used on Plates I



and II, namely, one-sixth of the height. They are meant to call attention to differences only. Scaled in millimeters, the space values are: line 1, 6.4, 4.16, 4.16, 4.16, 4.16 mms.; line 2, 4.16, 3.52, 3.52, 6.4, 5.12 mms.; line 3, 3.85, 3.83, 4.16, .64 mms.; line 4, 3.2, 3.51, 2.4, 3.2, 4.16 mms.

Let us look at the areas of the spaces between the letters measured only approximately in square millimeters. We find those in line 1 to be 84, 105, 105, 75, 75 sq. mms. respectively; line 2, 75, 115, 115, 84, 86 sq. mms.; line 3, 77, 88, 75, 82, 91 sq. mms.; line 4, 150, 108, 143, 113, 68 sq. mms. The average area is 96 sq. mms., very little in excess of the unit, or 84. The maximum difference between any space and the normal unit is 66 sq. mms., or three-quarters of the space between **H** and **N**. Excluding the **L** and **T**, where there is much space left outside the letter form the maximum difference between the spaces and the normal unit is 21 sq. mms., or a little over one-sixth of the area between the **H** and **N**. The inference to be drawn from this is that it substantiates the claim that when laid out with a view to uniform effect the **spaces** are **nearly uniform in area**.

Of course the uniformity is less in evidence the narrower the average spacing, because the spaces left unoccupied by letters count for more in the space areas. If the **T** and the **L** were put closer to their neighbors, then, independent of the effect on the equivalence of area, they would be too close for uniformity in the line.

Notice that the **V** and **A** have zero clear distance

between them; in narrow spacing it is quite necessary to make their limits even overlap. The same may be said of the **R** and **V**. A theory as to a definite clear distance should not be allowed to interfere with freedom in design.

The uniform weight of the stems of all these letters makes the problem of spacing easier than it is in the case of a varied stem letter, such as the Roman; in the latter it would be found that the areas of spaces would be less uniform because of the modifying effect of the variations in the stems. It is not so easy to arrive at a determination as to the proper value of such spaces.

Plate VII is given to show the application of these principles of spacing to lines of lettering; the footnote to the plate gives sufficient explanation of the meaning of the treatment.

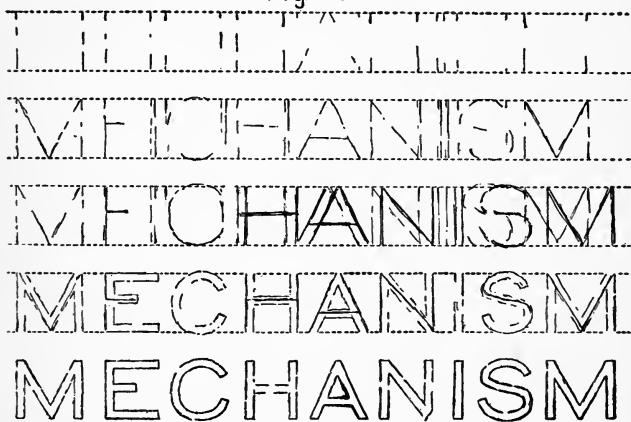
## 20. Development of Proper Space by Sketch Method.

The safest rule in careful lettering by which to get space values is to use sketch methods and by correction and adjustment to bring the lettering to such a finish as appears well; until the eye is trained to appreciate unaided the small differences the final result will not be likely to be satisfactory.

**Fig. 4** illustrates a way to do the sketching. This figure shows, as nearly as it is possible to make it for purposes of reproduction, the way in which the word *mechanism* was built up, when the limits, beginning and ending, of the word were not fixed. The first line,

assumed to be made in pencil, gives a brief indication of space and width of letters, beginning at the left and proceeding towards the right. The second line shows how a more careful calculation has been made by giving the letter spaces a treatment that suggests form. The lines of the first stage are still preserved to indicate the

Fig. 4.



amount of the correction. The third line shows a somewhat final determination of the values of letters and spaces, still displaying underneath the first tentative efforts at shaping. The corrected result is shown in heavy stroke. The fourth line is freed of the elementary efforts by erasure of the pencil, and shows how the letters are both more carefully shaped and the thickness of

body suggested here and there. At this stage it is quite possible with a skillful hand to begin to ink the letters in their final form, but an additional line is shown in which a more complete sketch in pencil is made. This last line corresponds in finish to line **e** of **Fig. 1**, the remaining stages being completed in ink.

While no mechanical aids are necessary in laying out lettering, yet it is quite in order, particularly for the beginner, nor is it destructive of dependence upon the eye, to have handy a mark of some sort, say the straight edge of a piece of paper, marked with the width of the normal letter, and also a normal space, i.e., which would exist between two vertical stems, and as the sketch progresses apply the scale now and then to check the calculation and to see if the values are varying satisfactorily.

## 21. Sketching Preliminarily in Outline Gothic.

In **Fig. 4**, the preliminary sketch-work was done in a single-stroke letter. This is a good plan to follow in the preliminary work of any design; the simpler the elementary forms are made, the less is the designer hampered in his layout of spacing and sizes of letters; the nicer differences in spacing due to weight of body and so on can be settled at a later stage of the work. In the word *mechanism* the **I** is the only letter in which the weight of body needs to be provided for in the earlier stages of the layout.

When the Roman letters are the subject of the design,

the serifs must be allowed for by sufficient additional space. The **minimum space** between any two letters will be something slightly **greater than twice the width of a serif**, for these should not touch one another in any case.

## 22. Spacing of Words, Punctuation, etc.

The spaces used between words and also after punctuation marks should be larger than the spaces between the letters of a word; the former can vary according to the space at the disposal of the draftsman, the limits being governed by the proportions of the separate letters. It must be remembered that *increase of spacing increases prominence of words*; in the same manner increase of spacing between words conduces to greater legibility. To give an idea of the value of word spacing, it may be stated, as a rough suggestion, that in ordinary cases of continuous lettering the space can vary between a double normal space and the width of one letter **plus** two normal spaces.

After a comma, semicolon, or colon the spacing should be greater than between words in the body of a sentence; the increase, however, should not be very great. If the same space is allowed, measuring from the punctuation mark, that would be allowed between two words in the sentence, it will be sufficient in the case of the comma and semicolon; for the colon it should be slightly greater.

The maximum spacing should occur after a period, and

should be greater by at least one normal space than that following a comma, and may be anything above that consistent with unity in the reading matter.

The question may arise, what constitutes a good spacing between letters in a word? The minimum of course is controlled by those two letters which will come closest together, like two **O**'s or two **A**'s, and from this it may increase to any value consistent with legibility. It is probable that the draftsman will cultivate a certain very limited range in relative value of space, relative, that is, to the proportions of the letters chosen, and it will always prevail in his work. It is very convenient to do this so that the minimum of attention can be given to this part of the subject, the rest concentrated upon the letter forms and treatment. Good practical spacing is illustrated on Plate VI.

## CHAPTER III.

### THE USE OF THE PEN AND OFFHAND LETTERING.

#### **23. Letters Should be Drawn Throughout, Not Copied.**

The draftsman should know how to handle his pen as well as shape his letters. Most of the lettering done will be finished in ink, although only the free commercial letter is put in directly without any previous pencil treatment—such a letter as shown on Plates VIII and IX. For the beginner it is desirable to make a careful rendering of the Roman and Gothic forms, first in pencil, where change and correction can easily be made, then later also carefully in ink, so as to become thoroughly familiar with them in all their details. In rendering these letters on a large scale in ink, *careful penciling should be the preliminary step*, and this followed as far as possible in the inking.

The **faults of letters**, however, are **not obviated by inking**, rather are they emphasized, and in addition many minor faults not apparent in the penciling, because of the gray lines, stand out boldly and clearly in the inked letters. Therefore, while the most complete pencil letter is advised before inking, it must be recognized that the drawing of a letter is really *not complete*

*until the letter is all finished.* Again, no matter how carefully the penciling may be done, it is impossible to copy it perfectly in ink. The drawing must proceed from the beginning to the final touch; at no stage can it be taken for granted that the drawing has ceased and copy work begun; slight adjustments will be found necessary to the end of the work, even sometimes to the filling in of the heavy-bodied letters, in which one would suppose, if anywhere, the process would be purely mechanical.

#### 24. The Kind of Pen to Use.

The best pen to use will depend somewhat upon the kind of letter to be drawn, but aside from this the touch of draftsmen differs, and what would respond to the handling of one would be a poor tool for another. Some find a stiff pen better than a soft one; it depends upon the ability to control the pressure upon the paper. For fine work on a small scale, neater than ordinary lettering upon working drawings, lettering suitable for a small map, for example, up to three thirty-seconds of an inch high, a **crow-quill** is a very good instrument; it will make very clear and fine lines, and can also be spread out to make a relatively broad sweep of black line about one thirty-second of an inch broad.

For ordinary lettering a **Gillott's No. 303** will be found very satisfactory. Any pen will be less responsive to the hand of the draftsman when either too new or too old, its life at best being but a short one. A new



pen, which is apt to give a fine wiry line with abrupt transition to the heavier strokes, can be worn down by scratching upon some rough substance; when a little old, on the other hand, the pen will refuse to make the fine strokes and will have points of weakness rendering it uncertain, so that it had better be discarded. If used on rough paper it must be coarser than if used on smooth paper, else it will catch and spatter the ink. Bristol-board or tracing-cloth will, either of them, permit the use of a fine pen.

There are two other grades of Gillott's pens for lettering, the **No. 192**, a finer, and the **No. 404**, a coarser grade. The **commercial stub pen** is a very good one to use for some kinds of rough lettering, on a working drawing, for example; such styles as 2 and 4 on Plate VIII come under this head.

For rather large, offhand lettering, with the small letters about 5 mms. (.2 of an inch) or more high and of the single-stroke Gothic style, a **ball-pointed pen** may be found very convenient. For a similar style of letter, less than 5 mms. high, the Gillott's No. 303 will do very well.

It is best, perhaps, for the beginner to experiment a little on pens, learning the proper kind of stroking, the capacities of the different pens, and then suit his final choice of pen to his handling. For the offhand lettering shown at the bottom of Plate V and that on Plate IX the pen used should be such a one as will, without perceptible pressure, make the full weight of

stroke desired, and should be held squarely with the paper, the pen-handle, that is, being perpendicular to the line of the lettering and immediately in front of the person. A slight inclination towards the right is feasible in making inclined letters, although this is not necessary.

## 25. The Kind of Ink to Use.

There was a time, not long ago, when the best ink for drawing was that ground up from the imported India-ink stick, but now the liquid drawing-inks are so satisfactory in most respects that it does not pay to grind what is needed. **Higgins' Waterproof Drawing-ink** is the one in common use. It should not be left exposed with the cork out. After dipping the pen in each time, the bottle should be closed to keep out the dust and prevent evaporation.

A draftsman may consider it more convenient to use a fountain pen sometimes, filled with liquid ink; it is not very satisfactory, however, as it does not flow freely enough and clogs up the pen outlet, giving frequent trouble. The ink will of course clog up an ordinary pen rather rapidly, and the latter should therefore be wiped frequently; it is a good plan to get into the habit of doing it just before each filling.

## 26. The Kind of Paper to Use.

In the drafting-room of a manufacturing establishment, architect's office, or any other commercial concern the paper that is used is chosen for its fitness for mechan-

ical drawing, and in the main works equally as well for free pen-work. Tracing-cloth takes the ink very well except that, being relatively non-absorbent, the ink tends to pile up on it in wet heaps. The most suitable paper on which to do lettering is that which is the smoothest, the **Linen Record** papers or **Whatman's Hot-pressed**, but best of all the good **Bristol-boards**, the **Reynolds'** or the **Strathmore boards**. The cheaper cardboards deposit a chalk on the pen and are not at all satisfactory. The possibilities of making a good erasure should be taken into account also, some papers working much better than others. The above recommended ones are very satisfactory in this respect.

## 27. How to Handle the Pen for Offhand Lettering.

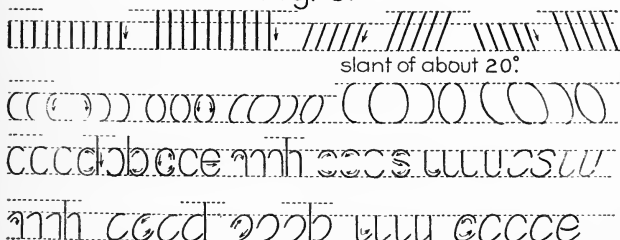
Although a ready familiarity with letter-forms is essential to facility in offhand lettering, yet there are reasons why the latter may to advantage be practiced before careful lettering in ink on a large scale is done. It is necessary to cultivate a steady and controlled handling, which may be gained by a practice of the different kinds of short strokes used in the offhand styles. First **rule light limiting lines in pencil** as guides for the height of the capitals and the small letters. These should, at least in the case of the small letters, be invariably used even in practical work.

Referring, for a time, in what follows to the offhand letter, such as on Plates VIII and IX, we see that vertical and inclined straight strokes together with the elliptical

forms, whether made up of one continuous stroke or several, should be possible with perfect control of the hand. These separate forms should be practiced. Keep a small piece of trial paper tacked to one side of the drawing-board; on this, after filling the pen, a start of the line should be made, cleaning out the pen with a rag and refilling if found not to work satisfactorily.

Try the stroking as shown in **Fig. 5**, the straight lines

Fig. 5.



first; it is the simplest kind that can be used and is the basis of the matter on Plate VIII. At first it will be difficult to make the continuous straight strokes of uniform width; to aid this, first hold the pen so that the plane of the pen axis and the line to be made are perpendicular to each other, then touch the paper, pressing the nibs of the pen apart to the proper width before starting the stroke; after starting, continue the motion uninterruptedly until the end, and lift the pen just an

instant after stopping motion, else the line will taper out to a fine point.

If a lump tends to accumulate at either end of the line it can generally be avoided by carrying less ink in the pen, combined with a briefer hesitation at the beginning and the ending. Whole-arm motion, too, may be found helpful in preserving uniformity in the weight and the direction of the lines.

If difficulty is experienced in preserving proper direction, whether for the vertical or the inclined strokes, rule light pencil-lines at frequent intervals to serve as sights for the eye to follow.

Next, try the curved strokes, preserving the direction shown by arrow-heads, still keeping equal spacing and uniform weight of strokes if possible. Practice making the elliptical forms with one continuous stroke, as this is the ideal way to treat the offhand letters. The weight of the stroke is governed by a certain minimum pressure of the pen on the paper; if the pressure is varied, a sidewise motion of the pen will give a different weight of stroke from that shown in the straight lines of the figure.

In these exercises the accurate spacing of strokes should receive as much attention as any other feature, for, although not important here, the practice is beneficial as preparing for the almost equal spacing of the strokes in the combined letters, for example the **n** and the **m**, and the equal spacing of the letters from each other.

A useful form to give this practical work, and rather more interesting than meaningless stroking, is that

demonstrated by the figure, which is to divide letters into their component parts, practicing each part separately for a time and then combining them into the letter; the significance of the different parts of the letter is in this way better appreciated.

If at any time it is desired to make a simple form of letter like these, but with a body heavier than can be controlled with one stroke of the pen, it is best, if possible, to use a fine outline with space between the strokes to be filled in afterwards. The use of contiguous strokes is very apt to result in irregularity, which must afterwards be corrected by touching up; still this is sometimes absolutely necessary. In such a case, it is best to work the second stroke against a wet line, for, if dry, black on black covers up defects in the free running of the pen.

Considerable practice is necessary in order to gain proficiency in offhand lettering, and a thorough preliminary groundwork in exercises, such as in the figure shown, are very profitable. The ideal of perfection in an offhand letter is never reached, but an acceptable result is obtained when there is an evident controlled freedom and intelligent handling, the errors in handling being uniformly distributed and not occurring strikingly here and there.

## **28. The Outline Gothic for Offhand Work.**

The outline Gothic in the figure just discussed, and as also shown on Plate V, is a type of letter which can

hardly be improved upon for an offhand treatment, both for ease in execution and legibility. An analysis of all of the letters into strokes is shown at the top, but it is only introduced as a suggestion of how to treat them. Different ways for the sequence of the strokes is shown; in skillful hands a continuous stroke will suffice for many of the letters, **E, C, O, S**, but it is almost impossible to make a vertical up-stroke as would be necessary for the **V, U**, etc. The student is advised to practice the letters singly, following this analysis and that of Fig. 5. A good groundwork in proper stroking in these separated letters is worth hours of subsequent practicing in practical application to drawings, for habits once formed will persist. In beginning the subject, much less practice is required than at first supposed, but being dry and uninteresting, is not apt to attract the student; this letter, too, may be practiced as an equally good groundwork for any of the other styles shown on Plate IX.

On Plate VIII are certain well-known and common variations upon the straight Gothic letter; they indicate sufficiently, in the few examples shown, how the rest of the alphabet may be treated without the necessity of having all the letters present on the plate. The student is advised to use discretion in the distribution of these variations in a line of lettering, because a too lavish use of them may result in weakening the effect of the whole.

The extended and compressed forms have their spheres of usefulness, and the student will find that he can soon

pass from the one to the other when occasion requires; however, **it is** advisable to cultivate for general use one proportion, and this one rather bordering on the extended form. A very short letter can be used if it is only made sufficiently wide. The legibility of a letter is increased more by a slight increase in width than by one in height. The extended form should in particular be used in the dimension figures on a drawing.

The lower line of **Fig. 5** shows an analysis of one of the variations just mentioned; a certain angularity of the curved forms is to be noted; the ovals, too, are made inclined and pear-shaped.

**The inclined Gothic** will have the same characteristics as the inclined letters on Plate IV; there should be sufficient inclination of stems to avoid the effect of a vertical letter carelessly made. Otherwise the amount of the inclination is governed by legibility; **20 degrees** from the vertical, however, gives a **good general slant**.

The remaining features of inclined letters were discussed in connection with this plate in sec. 14. The footnotes to some of the other plates are in the upright and inclined Gothic. Plate VII illustrates one of the variations; Plate XIII, a back-hand form of the Gothic; Plate XI, the inclined.

## **29. Other Offhand Styles.**

On Plate IX are several other styles of letters for offhand work. **No. 1** is but slightly different from the single-stroke Gothic just discussed, but in the small



letters the oval forms are simplified, and one who, after practicing sufficiently, becomes convinced of his inaptitude to make clear round forms can resort to this with promise of better success. The capitals can also be treated in the same square construction.

Some may find the swelled-stroke letters of lines 2, 3, 4, 7, and 8 suit their hands better, but the uniform strokes just described should be mastered in a measurable degree first, for use in larger uniform letters, in titles, etc.

Nos. 3 and 4 go together, also 7 and 8. They are shown, although nearly alike, because the difference in direction of inclination involves a difference in the swinging of the strokes.

In the **swelled-stroke letters** the position of the pen relative to the line made should be the same as for the other offhand styles discussed, but motion should begin and end *somewhat gradually after touching the paper and cease gradually on leaving it*. Keep a strong pressure equally uniform, and cultivate a uniform way of bearing down at the beginning and a lifting up of the pen at the ending of strokes. It is true that in this form of letter minor defects are less noticeable than in the more rigid forms. A few useful exercises for preparation in making this kind of letter are shown in Fig. 6. The chief difference between the upper group of two and the lower group is that the strokes in the lower group are swelled uniformly, while those in the upper emphasize the lower parts of the letters; this,

carried even farther in the matter of concentration of weight, is illustrated in the footnote to Plate VI.

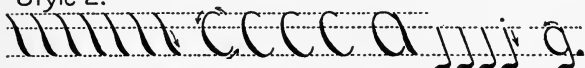
No. 5 is suitable for a heavy blunt pen that is apt to spill the ink, or for a stiff pen which does not obey the handling readily, or the ball-pointed pen.

No. 6 is quite a favorite with some who admire the

### Fig. 6.

Analysis of the stroking on Plate VIII.

Style 2.



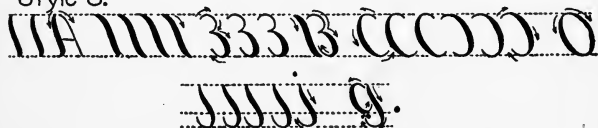
Style 3.



Style 7.

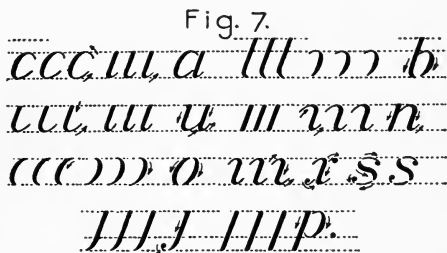


Style 8.



Roman letter; it is distinguished from its parent by having no fillets to connect the serifs with the stems. The small letters may be of the stump form shown on Plate V. It is made, of course, with the minimum of handling, the heavy strokes with one sweep of the pen, their imperfect ends afterwards trued up with the serifs. It is undoubtedly one of the best appearing letters upon

a drawing, but it requires special aptitude in lettering to do it rapidly enough to suit the requirements of practice. Fig. 7 is introduced to show the kind of



practice stroking for the style where the stump writing for the small letters is used.

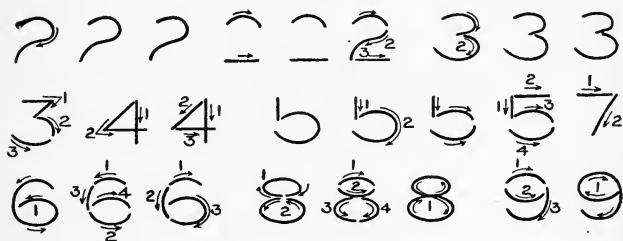
The numerals used in connection with the offhand styles need not necessarily partake of the characteristics of the latter. An important thing to observe in numerals on a drawing is that they should be fairly legible and, as before mentioned, this is effected more by increase of width than of height. Therefore a figure that is broader than its height is more common on working drawings; examples 9 and 10 show figures applied to a drawing. Consult Plate XII for a very broad figure.

Fig. 8 gives an analysis of the strokes used in making the simple single-stroke figures on working drawings. A more careful treatment by dividing up figures into more parts can be used when desired on larger work.

On Plate XVII will be found other free styles of off-hand letters, more used, however, by architects; they

are copies from the authorities whose names are printed under each. In some such ornamental styles as these the defects of unsteady handling are not so likely to be offensive; particularly is this true of style *e*. But lack of facility which is thus disguised must be replaced by

Fig. 8.



a rarer quality, judgment in the appropriateness of the variations to the general make-up.

### 30. Some Special Directions about the Use of the Pen.

(a) **Kind of penciling for inked letters.** The penciling which is used prior to the inking should be of the lightest possible, and soft so that it can be easily erased, and the eraser, too, one of the soft kind so that it will not injure the ink or paper. For offhand lettering the only penciling used should be for the guide-lines; for careful large lettering the penciling should be as complete as if it were to remain in pencil except as regards the blackness of the lines. The paper should be kept as pure as possible, even a minimum erasing of the pencil-lines,

so that the ink will take freely. Ink will not flow freely upon a dark pencil-line because the lead is more or less greasy.

(b) **Filling in the thick stems of letters.** In filling in the thick stems of letters the **pen** should be **used like a brush**. A fine outline is first drawn ideally with steady continuous strokes; this furnishes a wall to retain the ink and should look like the **H** in **Fig. 1**. Continuous paint-brush-like strokes are next drawn within the wall, the long way of each member, touching each other if the letter is not too thick, until the whole is filled. If for a very thick body, a middle stroke may be taken, as in **B** of **Fig. 1** and allowed to dry before completing the rest. This process is desirable because it does not disturb the paper by tearing up the fibers. The scratching by short strokes, usual with beginners, will do this, making blots likely and leave its ear-marks generally throughout the surface. In a broad and general way, **use the pen as a painter uses a striper in sign-painting**.

(c) **How to correct errors in inking.** First wait for the mistake to get thoroughly dry, then always use a sand rubber, or in other words an ink-eraser (never a knife). Rub lightly *in all directions*, and by slow degrees clear the paper thoroughly in the immediate neighborhood of the error, not being troubled because it cleans off somewhat more than the mistake. Next clean off the sand with a pencil-eraser, and finally burnish down with the ivory end of a penknife or that of a regular knife

eraser. Pencil in as if for new work and then ink it over, manipulating the pen with extra care over the erased portion and also when filling in has to be done; the ink is more liable to spread here than elsewhere, overrunning its boundaries.

**Erasing-shields** can be purchased and are very handy for small errors; they consist of a piece of thin sheet brass having holes in it differing in shape and size. It holds the paper down tight and prevents the cleaning of a surface larger than necessary.

(d) **Points about lettering on tracing-cloth.** It is convenient to slip a piece of fine cross-sectioned paper underneath the cloth to furnish the guide-lines or to rule the lines in pencil on white paper and slip this under. The smooth side of cloth holds the ink wet on its surface longer than paper, hence use less ink at any time in the pen, and particularly in making additions to strokes and in trimming up.

If a mistake is made, use, as before, the ink-eraser very carefully; no burnishing upon the cloth will be found necessary, in fact it is impossible. Not more than two or three erasures over the same place can be made at best on even the smooth side of the cloth before it will give way

### **31. Proper Size for Offhand Lettering.**

The size suitable for offhand letters for working drawings depends of course upon the proportions of the letters. A narrow small letter can be one-eighth of an

inch high or even slightly higher, whereas, if a broad letter is used, less than one-sixteenth of an inch will suffice. Beginners are apt to err on the side of a letter too large. Those on Plate VIII show a good size to use, also those shown on the working drawing on Plate XII. The footnotes to the various plates show suitable practical sizes.

## CHAPTER IV.

### DESIGN OF LINES AND OF TITLES.

#### 32. The Single-line Title.

Consider now a kind of careful lettering which we find instanced in a caption to a drawing, one line of words to designate a subject. What constitutes an appropriate letter for this purpose, and how is it best to treat it? Titles of course involve, in a measure, design. We will not speak now, however, of the designed letter found so commonly in advertisements, where the best lettering is to be seen to-day, but simply of those points of design which involve the choice of some very simple letters *treated in an invariable way*. There is a system which can be followed and which will insure intelligent treatment and appropriateness to the purpose intended. Such a title we find, for example, across the top of working drawings or that of the U. S. Geological Survey maps so familiar to every one.

In designing a title, a student must keep in mind the fundamental requisites of *appropriateness*. The tendency in beginning always seems to be to make lettering too prominent. Just what size and character of letter to use is governed by the requirement that it should



keep its place, and that place, is one generally of lesser prominence than the drawing. The lettering should not be striking, but legible and neat.

### 33. The Choice of Style and Size.

Assume the styles to be chosen from among the very few well-known ones illustrated on Plates I to VII and applied to working drawings or maps. To-day the marked **characteristic of good lettering is simplicity.** The day of ornamental lettering is past, if it ever really existed outside the covers of the imported books of alphabets, also that of the letter drawn in perspective as if it stood out from the paper and the place where it properly belongs. The design of the letters themselves appears in slight modifications and in adjustments to one another in their places in words. **No more fitting letter** for a single-line title can be found **than the Gothic** illustrated so abundantly on Plate VII, and it must be conceded that it is also the simplest.

The choice of style will depend somewhat upon the character of the drawing. **The U. S. Geological Survey** calls for Roman and Gothic letters together with italics exclusively; the working drawing of the engineering establishment usually includes these together with the other simple styles which are slight variations upon them. The display or show drawing may have slightly more ambitious treatment, although it is not usual to do more than make the letters heavier. The architectural drawing will display a letter which is the product

of a more artistic hand than the foregoing. The architect likes to be free in his treatment, and not infrequently gives expression to rather weird forms entirely out of the conventional, but characteristic of his profession, a letter such as we see on Plate XVII. It is not always sure to be legible, and this is its chief fault, but because it is rather traditional in the profession it is accepted with less criticism than it probably would receive elsewhere.

**Titles are generally put wholly in capitals.** For a little more compact treatment large and small capitals are sometimes used, the relative height of the latter being greater than if small letters were used in their place. We very much less frequently see titles composed of capitals and small letters. For much matter in small space, however, this arrangement is very efficient, for it can be easily read, probably more easily than if capitals of equal proportion and treatment were employed.

It is difficult to give any directions as to size of letter, for the effect depends largely upon treatment. Perhaps it is safe to say that the limit in height of the letters on a working drawing can be taken as one-half of an inch, this when a light body and narrow letter is used, of the proportions, for example, of the letters in 1, Plate XI; and the limit for weight of body, if a Gothic or Roman letter, one-sixteenth of an inch, in the case of a short broad letter.

It is probable that one will fall by habit into making letters of a generally similar proportion and even with

a tendency towards the same kind of spacing, so that choice reduces to a question of what length the line of lettering is going to be or of the amount of wording to go into the line.

### 34. How to Lay Out the Line.

Sometimes the space for a title is fixed in length; as an exercise for practice work it should be. An idea of about what size letter will do for a given space can be determined by sketching roughly on a piece of trial paper without limiting lines.

Next, the balance of the line can be ascertained by counting the letters, finding the approximate middle of the line, possibly even the quarter and three-quarter points. This is accomplished by counting both words and spaces, also by the position of the largest letters, **M** and **W**, and the smallest, the **I**, in the line, and allowing for them.

After this the method of developing the line should be entirely analogous to the development of a word, as discussed in sec. 19. The gradual sketch development is preeminently the safest and most expeditious. The first, last, and middle letter may be lightly drawn, then those in between, as was the word *mechanism*. The spaces between words can always be used as equalizing factors, being expanded or contracted to suit the length of the line.

In the first rough layout the single-stroke Gothic may be used whatever is to be the character of the letter

when finished. After allowing for any extraneous differences, as in the addition of spurs to a Roman letter, the **I** needs to be allowed for; the weight of its body decides the space required by this letter, which it does not in the case of the other letters.

### 35. Degree of Finish to Give a Title.

Titles are frequently made more or less offhand, that is, rapidly and directly in ink. To do this well without careful preliminary penciling requires considerable practice. The single-stroke Gothic letter, of capitals throughout, is frequently used in such cases; it should not require more than a few minutes to put in a line of it. Of course the treatment looks offhand and does not have the appearance of the titles on the U. S. Geological Survey maps, but for the requirements of general office work it is adequate.

A title put in to look as if engraved or printed from type requires exquisite care in its handling; such cannot have too careful preliminary penciling. The degree of finish to impart will depend also upon the character of the drawing to which a title is attached. Neat exact drawings for photographic reproduction require a neat exact letter; this should be treated with the careful penciling mentioned, copied carefully also with a very fine pen, possibly a crow-quill, rendering in a fine contour, with attention mainly to the outer edges of the strokes. This contour can afterwards be filled in with a coarser pen or brush.

General working drawings, for office and shop use alone, permit only of a very free treatment. Broad, sweeping, and continuous strokes are in order; if possible the full weight of the stems of the letters; if not, then it is necessary to add to them while wet until the strength is attained that is demanded by the letter. Touching up of lines is generally impracticable.

### **36. The Design of Grouped Titles.**

A grouped title is such a one as we see on Plates X and XI, where a certain amount of information is separated into lines, generally grouped in the lower right-hand corner of a working drawing, occasionally in the upper middle part. Maps, the drawings of architects, and the working drawings for shop use contain these. To make a neat-appearing group of the subject-matter requires considerable taste and practice. The division of the subject-matter into lines may not require much discretion if the title is not extended; the title of the sheet, the firm name, address, and connectives generally compose the material, each naturally requiring a separate line.

After arranging the lining of the title, be assured that the best all-around effect is obtained by simplicity of treatment. It may be remarked, in passing, that the generality of titles upon working drawings ignore this one fundamental principle of all design; the first effort seems to be directed to choosing a different style of letter for each line and obtaining prominence of certain fea-

tures by elaborateness of alphabet. A single style of letter can be used in the make-up of a title, and it can be diversified with sufficient difference in effect to suit the most fastidious. **The fewer styles used in any case the neater will be the design.**

### 37. Various Considerations to be Observed in Designing.

There are a number of things to be observed in the designing of a title to completely fill its purpose, which will now be taken up severally and discussed.

(a) **Simplicity of contour shape.** Notice examples of good lettering to be met with daily in our advertising matter; we can see that the groups possess simple shapes; tangents drawn to the extremities of the successive and prominent lines *enclose a simple geometrical figure*, rectangular, trapezoidal, or one of simple curves, the figure sometimes actually lending a certain special interest to the group. If, in grouping lines of letters, they are spread apart and made more scattered, perhaps by virtue of marked differences in lengths of line, these tangents will not enclose a simple but a rather complex uninteresting figure, disturbing the unity of the subject. Notice the shapes of the titles shown on Plates X and XI. It is probably a good rule in sketching the layout of such titles as these to design the title without regard to the connectives, putting them in afterwards and suiting their treatment to the room at their disposal. The shape should be given by the principal lines.

(b) **Proper relative prominence of lines.** The chief feature in the title should be brought out with sufficient prominence to catch the eye at a glance but it should not be so large or prominent as to entirely dwarf everything else. Other lines will also require more or less prominence. Each line should take its place in the general scheme, none attracting more attention than its due. In a short title of a few lines it is not difficult to decide upon the relative prominence of the parts. In more extensive titles, two or more lines may seem to require about equal prominence, yet, from considerations of design, should not be treated exactly alike or, even if treated alike, being of quite different length, would vary in their prominence. Such points as these should be appreciated.

(c) **Matters affecting prominence of words.** Change in the prominence of a group of words making up a line of lettering can be effected in a variety of ways and by combinations of these ways; for example: **change in proportions** of letters, particularly in the width; **change in the spacing** of letters and words; **change in the weight** and treatment of the body of letters; **change in the alphabet style** or by slight variations or ornamentations, and lastly, **italicizing**. This, it may be observed, within a group of lines of upright letters, will be more prominent than the rest, even though of the same kind of alphabet, and treated the same.

Some of these features of course affect the appearance of the words in a line more than others; just how much,

relatively, is a matter to be settled by experiment. Any one of them applied to a very slight degree will effect a noticeable change, because what is done to one letter is repeated in many letters of the line, and in the aggregate becomes noticeable. Therefore it can be readily seen that if several of these expedients are used together each must be dwarfed over what it would require to be if used alone. The tendency of a beginner in designing groups of lines is to give altogether too much prominence to important features, hence the reason for giving this caution.

(d) **Uniformity of treatment.** The whole title should receive equal finish in treatment. To draw one part very carefully and to make another part offhand with the intention of lessening its prominence is a mistake in design. The title should be treated either all carefully or all offhand. Again, if all capitals are used in the prominent features, all capitals should prevail elsewhere, with the exception that some one line alone may be thus varied. In a title mainly of capitals, capitals and small letters may be used appropriately for the unimportant connectives "of the," "by the," "manufactured by," etc., unless perchance they appear frequently in the title separating almost every line from its neighbors, when if used this treatment would appear to be broken up.

### **38. Example of How to Lay Out and Execute the Design.**

The method of laying out a group title should be the



same as that used for the line or for the word, but it is here described again so that its slight variations may be thoroughly understood.

Plate X shows the way to proceed in the development of a design. Before deciding upon the style of alphabet or alphabets to be used, **separate the matter of the title into lines**, giving the connectives each a separate line; this is not invariable, however, as **title 3**, line **c** on Plate XI, shows, or the same subject in **b** of **title 4**. The arrangement is shown in the first line of **s** of the plate, together with an approximate estimate of the center of each of the lines.

With some conception now of the general make-up, **ske ch** with very **brief suggestive treatment**, the whole title in single-stroke motive, as the group number **2** on the first line of the plate shows. To allow perfect freedom, this may be done without limiting lines, these attached afterwards, and then the letters trimmed to fit them. The limiting lines shown on the plate are an attempt to suggest this kind of treatment.

After trimming up and balancing, as was described for the single-line title, the effect is that of number **3**. Here the proportions of the letters and the spacing have been determined quite accurately.

Now since so many things determine the effect of the lines, it is well to **experiment** on the **treatment to be adopted for the several lines** as shown in number **4**. The two halves of the title on a vertical division-line shown in number **3** might be treated differently and afterwards

a choice made of the one which, upon being worked up to a finish, promises the best. This may be done in pencil, in which of course each of these stages described is supposed to be treated.

Finally, the complete title is shown at number 5, arrived at by the method described for the single-line title.

The above is a comprehensive method of designing, permitting the designer complete freedom in the development of his motive. No designer can exactly foretell his result so that he can begin and draw each line or, further still, each letter carefully from the beginning until all are done.

### **39. A Title may be Variously Treated.**

The beginner is advised to practice upon the possibilities of variations in a title by sketching a number of layouts roughly, to the degree of finish of number 4, and using several forms of titles, then to pick out the best one or several upon which to impart a careful finish.

What may be done in the way of slightly varying the treatment of a title is shown on Plate XI. In **1** and **2** the respective lines are of the same height, and the proportions of the letters also are the same except in line **c**. The **difference in effect** and of the prominence of the lines is accomplished by **weight of body alone**. Note what a slight difference is really made.

In **3** the whole scheme of the title is different. A

change in size of letters is also shown on the same line in **c**, yet, because of the difference in significance of the words, it is appropriate. It is true that "of" in the line "City of Ithaca" in **1** and **2** is made small, but in **3** the smaller letters of line **c** occupy more space and they also begin the line.

Number **4** shows an arrangement and treatment suited for the working drawing for shop use when the minimum of time is allowed; it is such a form as may be put in directly in ink after gaining experience in lettering. The difference in prominence of lines, it will be noted, is effected mainly by differences in heights of letters; the weight is that of the single stroke of the pen.

Number **5** shows also an offhand treatment where a more ornamental letter than the single-stroke Gothic is desired. The title shows visibly the ear-marks of the offhand treatment. Note that in the first four of these the same style and treatment of letter is used, yet there is no lack of variety; only two styles of letter are used in **5**, one all capitals and the other capitals and small letters uniformly.

Other facsimile reproductions of titles are shown on Plates XIII and XIV. These are discussed in detail in sec. 43.

## CHAPTER V.

### LETTERING FOR VARIOUS TECHNICAL PURPOSES INCLUDING PHOTO-REPRODUCTION.

#### **40. General Statement.**

All drawings for technical purposes, such as survey maps, working drawings, and the like, require to be lettered to some extent, sometimes carefully with very great finish, in other cases as rapidly as possible consistent with legibility, directions and data even being written occasionally when the draftsman is hurried in his work. The different purposes for which drawings are made control the character of the lettering, the different professions having their own characteristics in this as well as in that of the treatment of the drawing. In the large drafting-rooms of manufacturing establishments, a certain style of letter is apt to be demanded on all drawings, and this is as much a part of the rules as those controlling the general make-up, conventions, etc. The following summary of general suggestions may furnish a fitting introduction to a few of these branches.

#### **41. Lettering on Maps.**

The survey maps made by civil engineers, of which those made by the U. S. Coast and Geological Surveys

stand as the best patterns, contain lettering which, although plain, is yet finely executed and are examples of about as careful lettering as are to be found anywhere. Plates XV and XVI, giving the requirements and conventions of the U. S. Geological Survey, will serve to show what kind of work this is. The handling required is of the best and demands very careful preliminary penciling. When maps, such as these, stand as permanent records and are to be consulted and followed by many people in their original form or reproduced in an engraving (particularly this latter), the extra time required to do careful work is compensated for.

Prof. Jacoby in his book on "Plain Lettering" (pages 66 and 67) gives some very useful directions with regard to map-drawing, and we cannot do better than to quote him:

"The position of the various names should be so chosen as not to leave any doubt as to where each belongs. Names of places are preferably put immediately to the right of the convention which designates its location, or as near to this as the preceding rule and the position of the names and conventions will permit without the appearance of crowding. They are all arranged in lines parallel to the lower border of the drawing."

"The names of divisions, like districts, townships, counties, and states, should have the letters spaced to make the names cover the larger portion of the division, the lines being graceful sweeping curves extending in the direction of the greatest length and placed approx-

imately along the middle of the width. The names of communications, like roads or canals, and those of rivers or creeks are placed by their sides, the spaces between letters and words being considerably increased, the latter proportionally more than the former. If space is equally available on both sides, the letters are placed with their bases towards the convention. . . . A very long stream or line of communication may have its name repeated, if desirable, at different portions of its length. In all cases the lettering should be arranged so as to be read by the least possible change in the position of the observer when the map lies squarely before him. The spacing of letters when separated more than four or five units will be sufficiently precise if their distances, center to center, are the same."

#### **42. Architect's Lettering.**

The lettering usual on architectural drawings is of a very free and sometimes artistic sort, is quite likely also to be of the careless rapidly executed styles spoken of before. Very little time is spent upon the lettering of the working drawings; Plate XVII shows a few examples of the more common letter forms used on these drawings, taken from the authorities whose names are printed under each. A certain freedom and uniqueness is noticeable; the architect is largely an artist, and because of this abhors the rigidity of the common type form of letter; letters, for him, must mould themselves to suit his fancy, spreading out, exceeding their limiting

lines and changing shape, the same freedom that is allowed in the use of other decorative forms.

A favorite with architects is a letter on the order of the old Roman, shown on the above-mentioned plate, treated in outline with an open body, the serifs freer and wider than in the classic form. Another letter much used is that illustrated in V on Plate XXI.

The requisites for a good practical architectural letter like those in common use may be described as extreme lightness of body, legibility, and an artistic freedom in shape and proportion.

It was just said that very little time is generally spent upon the lettering on the working drawings. These receive much less care than the assembled elevations, but this does not negative the fact that it is experience which begets rapidity. The apparently careless letter is apt to be the result of considerable experience and facility with the pen. The nature of the lettering used on architectural drawings does not differ in other respects from that in other lines. In the titles to the assembled elevations we note a very frequent irregularity in shape, the information not being built upon a central line of symmetry, but staggered (see Plate XVIII). Another form very popular to-day is to make the lettering continuous in lines of equal length, as also shown on Plate XVIII.

#### **43. Lettering on Working Drawings for Manufacturing.**

The character of the lettering used on working draw-

ings has been already described in secs. 28 and 29. It only remains to call attention to examples and to give a few additional practical points.

Plate XII shows a drawing with the usual descriptive lettering attached, consisting mainly of dimension figures. Clean steady strokes in this are essential to clearness. Letters and figures should not be made so small as to run together and blurr. If a small figure is necessary, use a broad one. Where cramped for space, it is better to place the figures entirely outside of that space and refer them to it by a free-hand line having an arrow-head on the end, as instanced in several places on the plate.

Treatment should be uniform throughout in the following way: the same alphabet, style, size, and proportion of letters and figures should prevail if possible and unless cramped for room in occasional places. All capitals in one place and capitals and small letters in another should not be used unless the intention is to make a certain feature more prominent. Capitals and small letters probably look the best for descriptive matter, although this is a question of taste.

If the usual symbols of one dash for feet and two for inches are used, they should be large enough to be understood clearly, should be large also at one extremity, tapering to a fine point at the other. Separate somewhat the figures standing for feet also from those for inches to avoid confusion. It is quite common to dispense with the symbol for feet, replacing it by "Ft." to further avoid any misunderstanding of the figures.



Two limiting lines should always be put in in pencil where as much as a word or more is to be spelled out; it improves the appearance where there is lettering scattered over a drawing; separating the words quite well also helps the appearance.

Plates XIII and XIV, taken from original sources, show some titles treated in an offhand manner, much as the lettering on Plates VIII and IX, and are what are to be met with frequently on working drawings. They are not, however, necessarily recommended as good examples to follow in design. They are more fully discussed in sec. 57.

#### **44. Lettering for Photo-reproduction.**

There is a technique of lettering for photo-reproduction which deserves some attention. In the first place the paper used should be very smooth so that the edges of all strokes are clear; if possible choose a stiff paper which is either clear white or bluish white; the yellow tinted papers do not give as good results. Tracing-cloth can be used also when necessary. Erasures have to be made very carefully whether on the paper or on the cloth, in order to avoid irregular lines, but there is one aid possible which cannot be used in general drawing, namely, Chinese white for cutting out or trimming up. The water-proof black ink is the best for, if Chinese white is used to trim with, the black will not be drawn into it, giving blurred edges. The penciling should be very light and easily erased, because, if left on the drawing,

it is apt to be reproduced together with the ink-lines and has to be routed out by the engraver.

Theoretically, the greater the reduction, the clearer and sharper will be the result, but in practice this is not realized. If there are very fine lines present, these, on great reduction, will break and appear ragged; also, if lines are very closely spaced, they are apt to run together; it has become the general custom of draftsmen, therefore, to work for a one-half reduction, meaning that the result is to be one-half the width or the height of the original. Occasionally drawings are made for a one-third reduction, meaning that the result is to be two-thirds of the length of the original. This is a matter optional with draftsmen, however.

There are two general processes for reproducing line drawings, the **photo-lithographic** and the **zinc etching**. The former is an imprint made upon and printed directly from stone. The latter is made by photographing the subject upon a sensitized zinc plate and subjecting it to the action of weak acid which eats away the zinc where the lines are, forming the matrix for a copper deposit, which last becomes the plate when further prepared. The photo-lithographic process will, by its directness, give a clearer, finer result, but it is only suitable for a relatively small number of impressions, whereas the zinc process can be made to reproduce almost indefinitely.

Plate XIX is intended to illustrate some of the peculiarities of reproduction by the zinc process. Two lines

of lettering are reduced to two different sizes. The letters R and E in the right-hand corner, one from each of the above lines, are reproduced the exact size of the original, showing, among other things, what a large reduction was made. Both were made with water-proof ink and a brush without any careful preliminary penciling. For certain kinds of reproduction this is an excellent plan to follow, because much freedom of handling on a large scale can be indulged in without sacrifice in the result. Slight irregularities in lines on a large scale are lessened by great reduction.

For general work, however, the example at the left hand of the sheet shows the difficulties encountered. Letters should not be drawn for a reduction which is to be less than one thirty-second of an inch high, for they are apt to blur in parts, nor should lines which are parallel be spaced so as to reduce to less than one sixty-fourth of an inch apart, for similar reasons.

Where there are marked differences in weight of lines on a drawing it will be noticed that the reproduction does not preserve the relative thicknesses; the finer lines will be relatively coarser than the original. In drawing then, for reproduction the draftsman should calculate the effect which his work will have when reduced; a certain coarseness of treatment should be observed consistent with the scale of the reduction; fine lines should be made coarser than if they are to be reproduced the original size. Only practice can be depended upon to give knowledge of the complete requirements.

The plate shows very clearly the effects of reduction upon certain faults of handling. Filled-in corners is one of them and unevenness of lines is another. The plate also shows how directions for reduction are specified to the engraver. It is best to give a specific size to which a drawing is to be reduced, and this in inches, because the engraver can then measure the same upon the ground-glass plate of his camera. Otherwise he would have to figure out the size to make his negative, and this gives an opportunity for error.

If a drawing is reproduced, it is often found convenient not to do any lettering, but in its stead to have the letters stamped on, or letters which are already printed cut out and pasted on in the proper places. It is a great saving of time in some cases.

#### 45. Lettering for Patent Office Drawing.

Drawings accompanying applications for patents in the U. S. Patent Office require to be lettered with reference letters, occasionally with brief descriptive matter. The rules governing the making of the drawings are in some respects quite strict. The following quotation from the "**Rules of Practice**" revised Jan. 2, 1903, covers the matter of lettering:

"Letters and figures of reference must be carefully formed. They should, if possible, measure at least one-eighth of an inch in height, so that they may bear reduction to one twenty-fourth of an inch; and they may be much larger when there is sufficient room. They

must be so placed in the close and complex parts of the drawing as not to interfere with a thorough comprehension of the same, and therefore should rarely cross or mingle with the lines. When necessarily grouped around a certain part, they should be placed at a little distance where there is available space, and connected by short broken lines with the parts to which they refer. They must never appear upon shaded surfaces, and when it is difficult to avoid this, a blank space must be left in the shading where the letter occurs, so that it shall appear perfectly distinct and separate from the work."

The large reduction of drawings to a size appropriate for the pages of the "Gazette," i.e., to about 3" wide, demands a very bold legible letter. The style which is used by the U. S. Patent Office draftsmen when they prepare drawings for inventors is the stump form shown on Plate V, with capitals like 6 on Plate IX. The standard set by these is followed largely in outside practice. A bold-face letter stands the reduction better than the single-stroke Gothic, and some form of graded stroke letter is therefore more appropriate than this.

#### **46. Lettering for Advertising Purposes.**

This form of lettering calls for discussion briefly, and chiefly to emphasize the fact that good lettering is very plain and simple. Plate XX is introduced to illustrate this concretely. It was stated in sec. 1 that the best examples of lettering to-day are to be found among advertisements. It is here that the problem is pre-

sented very forcibly to make a strong impression upon the reader by catching his attention quickly and saying much in little space. Notice what very plain letters are used in most of the examples on this plate, yet on the other hand what freedom and scope is allowed in them.

Illustrations **A**, **C**, and **F** contain some of the very simplest, plainest letters, yet in **A** notice how the slight variation from the Gothic imparts a new interest to the letters. In **C** the style is very similar to the offhand style shown on Plate VIII; its prominence consists in the proportions of small letters to capitals and in the compactness of the line. It was drawn to show how a large amount of matter might be put in a small space, yet by italicizing it its prominence, in the midst of other very prominent lettering, will permit it to hold its own thoroughly and tell its story without interference. The **A** by its black ground and bold white face is striking and is well adapted to magazines, where it has to compete with other claimants for attention. The letter used in **B** is based on the antique Roman shown on Plate XXIII. The antique Roman, together with such variations of which this is an example, are favorites with designers to-day. In **D** will be recognized an old form of letter belonging to the much ornamented class we used to see, and in fact do yet, in the imported books of alphabets. As shown here it is modernized, however, and several forms of ornamental adjuncts are suggested as appropriate to

go with it. These last are of more use when the letters are to be reproduced in color by lithography.

The design feature in the first four illustrations consists chiefly in arranging the matter in the allowed space with the maximum of effect. But this is in itself no mean task, and likewise it is not a mean one to make appropriately the slight variations from the standard forms used, which alter quite noticeably the effect of the several lines from what they would be if straight letters were employed. The **Gothic** letters, probably first, and the **Roman** next form largely the basis for advertising lettering. The interested reader is asked to notice this in the examples which come under his attention daily; the slight variations found do not hide the type form. The illustrations **E** and **F** are introduced to show how the advertising lettering may take upon itself the characteristics of ornamentation. As a general rule, ornamental lettering has a very limited use in advertising; **E** shows about the length to which the fanciful may be carried, even this to no considerable extent, for it is not highly legible. It ought to be explained here that the illustration was purposely placed across the page so that the neighboring lettering through boldness would not detract from its legibility and interest. In **F** we have also ornamentation, but mainly of the surroundings of the letters rather than of the letters themselves. It shows a kind of unique "layout" and suitable for lithographic and newspaper work, where we see it illustrated very frequently. In these last two

illustrations it is evident that the artist and designer is necessary in order to do the work in hand; in no class of lettering is there, in all of its phases taken together, so much freedom allowed the draftsman, in scheming out his effects, as in advertising; the fact that the bulk of it is composed of very plain letters is a testimonial to their value, and the student should realize that design, in lettering at least, does not consist in ornamentation, but rather in a nice fitting of means to ends, the end always containing legibility as one of its chief requisites.



## CHAPTER VI.

### THE DESIGN OF LETTERING.

#### 47. General Statement.

Some of our best brush artists do not consider it beneath their dignity to occasionally design groups of lettering; they would not do this if they did not consider it as a worthy field for the expression of their fancy, or that letter forms were so rigidly fixed that they had but to scale them and their spaces. Artists have a keen sense of values and are strongly opposed to mechanical treatment. An inspection of some of their first-class work will show how the fancy has scope both in proportioning and spacing even when rather simple letter forms are used.\* The beauty of the work is at once apparent in its ensemble, the nicety of relation between the letters and space areas making a piece of lettering as much a unit as a piece of floral design can be. Artistic sense and the ability to design is something which cannot be easily taught, it must come inspirationally from within; the teaching which can be done does not lead to conformity to rules or rigid limitations;

---

\* See Frank Chateau Brown's "Letters and Lettering," for examples.

only suggestions can be given for the apt to apply, adding their own originality and initiative. It is proposed, therefore, to collect here a few hints in the matter of designing letters which may, perhaps, not only be helpful to those who intend to design, but an inspiration to those who will be more mechanical and rigid in their treatment, showing them how helpful is the attitude of the artist and how much latitude is allowed the designer. Nothing more than suggestions are possible.

#### **48. Single-stroke Gothic may be Taken as the Basis for All Design.**

In designing lettering to fill a given space, it is absolutely necessary, as a fundamental requisite, to treat the space in some such comprehensive manner as was outlined in the beginning of the book for a word or a line of words. The proper proportioning of wording to space available, so that the space areas may be uniformly or appropriately distributed, is the very first consideration, and may be outlined somewhat irrespective of the style of letter to be adopted; indeed the requirements of ratio of letter area to space area may be the determining factor as to what style of letter should be used. The space must be taken as a unit and, **considered as a whole**, that layout or distribution made **which comprehends the final result in each stroke**. In lieu of a more definite conception, single-stroke Gothic letters may be used with which to lay out this basis of the design. It is a very simple, easily made form, and a

number of tentative layouts can be made with it, choosing the best from among the number for finishing. The style or type of letter may next be chosen which will best fill out the skeleton form of the Gothic. The lettering in the space may be conveniently divided into masses also and each mass treated separately, but, generally speaking, the method of design must be comprehensive; the designing cannot begin with a complete finish at the top, proceeding little by little in the same manner to the bottom, for, if so treated, the result will inevitably lack unity.

#### **49. The Preservation of Type Style.**

In designing letters, that is, in originating forms or in modifying the existing well-known types, uniformity in the style must be observed as a prime requisite. Those who have studied carefully the earlier pages of the book will understand what type style means, but a few additional explanatory words may be appropriate. The Gothic letter has a body of uniform thickness; any change in the way of proportion, thickness of the uniform body, and so on, is in order, but as soon as different parts of the letter body are made of different weights, there is a characteristic change in the letter which must be accompanied by a corresponding change in all the letters of the set used in the design. The Roman-Gothic letter on Plate XXII may be pointed out as coming under this class; it has the characteristics of both of these styles. Now, were spurs to be added to a

T or an L in the last-mentioned alphabet, it would be necessary to add the serifs complete in all the letters, else an incongruity in the lettering would be at once apparent to even the uninitiated; it would be as striking an incongruity as dotting a capital I or mixing in small letters where capitals prevail. An embellishment or modification in the stem of any letter must therefore be accompanied by a like change in all the letters of the set; similarly a swelled body letter like S or G, as in the Roman, requires all the curved forms to vary in weight alike. With these points upon the type style, the student may be assisted in supplying the letters variously missing in the alphabets shown throughout the plates.

Frank Chateau Brown, in his book before referred to, presents the matter of type style very clearly when he says: "An important consideration in the design of an alphabet . . . is that the letters should be systematically treated. . . . There is no reason why we should not cross the breed in lettering, if thereby we can improve the stock. An alphabet, however, should not look hybrid. The artist is free to do what he can, but the test of success is that his creation should look as if it must be so, and could not have been otherwise. . . . Each and every letter of an alphabet, also, is susceptible to such modification in shape as may make it best suit the space left for it by its neighbors." Again, in the matter of design in general: "Why, it is asked, should the artist trouble himself about a hand-drawn letter, when he has ready to his use type, which is so much

truer and more perfect? Truer, perhaps, it may be, in the sense of being more mathematically exact, but it is not necessarily as truly uniform in effect; for the unyielding letters of the type-founder come together as best they may, and if they come awkwardly he can't help it. The designer can, and indeed he should."

### 50. The Old Roman Letter.

As affording suggestions for the beginner in designing, attention is called to a careful comparison of the Roman letter as shown on Plate I and the **Old Roman**, so called, on Plate XXIII. If the student has access to various authorities for this letter, he will be able to note quite considerable variety in them. This form is, as has been already mentioned, a very common and popular one to-day and is a good starting-point for the designer. Notice wherein the two alphabets differ. In the transition from the one to the other there may be an infinite variety in the forms. Notice, too, what a smooth and graceful letter the Old Roman is as compared with the present-day type-letter. Note the reasons for this: serifs are large; there is a lack of rigidity in the forms, that is, there is a wide variation relatively in the widths of the letters; the free swash-tails of letters like **R** and **Q** are prolonged into graceful curves, overstepping the rectangular boundaries of the letters; the upper and lower parts of **B**, **K**, **R**, **S** are quite dissimilar in size, breaking up symmetry while not entirely destroying it. From this letter it is a very easy step to the freer form

of **line 2** on Plate XXI. One does not find the Old Roman small letters illustrated as often as the capitals, partly because the small letters came into use later. The lowest line of the plate gives examples of different forms of letters of this alphabet which are to be met with, and by an observance of type style one is able to see how the various modifications apply to the other letters of the alphabet.

The Old Roman may be either heavy-faced or light-faced, that is, the ratio between the heavy and the light strokes may vary between wide limits. Lines **4** and **5** on Plate XXI show how they appear when light.

### **51. The Effect of Changing Proportions and Spacing.**

A very decided total change may be imparted to a given piece of lettering through simply a change in the proportions of letters, weight of body, and spacing, while keeping the same style throughout. This is exemplified even in the more rigid titles of Plate XI. Any desired contrast can be obtained between the several lines. Often in advertisements may be seen one word only, or one word followed by a line of but few words of plain style, strong and vigorous in their effect, the relation of body to space areas in the first case, and the contrast in the size and proportions of letters in the second, being the chief design features. As to the influence of these features relative to each other no principles of value can be given; there are so many variables and differing conditions that experiment

alone can determine the effect desired. It would afford an interesting exercise for the student to design a few groups, using the same material and varying it after such a manner, experimenting upon the differences in effect obtainable.

## 52. Other Considerations in Design.

In taking one of the familiar type forms to modify or act as a basis for design of letters, the chief object is to add interest to the letters and increase the prominence. Embellishment or ornamentation will do this, but only up to a certain point. If it is carried too far, the interest is destroyed because the letters become less legible. This does not mean that shapes of letters cannot be varied through quite wide limits; it is safe to do this as long as the characteristics of the letters are preserved.

Additions to the outsides of letters, in the way of scrolls, ornaments, shade-lines, lines to suggest a solid letter standing in space, should be sparingly used; they are of doubtful value as designs, particularly the last. Chief interest resides in a letter which has a pleasing shape in itself without extraneous ornamentation. Shade-lines, however, are probably more common than any other form of finish; rightly used they do add a certain easily obtained prominence; notice the letter *a* of *Masters* of Plate XX. As an example of what a slight variation of a fundamental type form may do in the way of adding interest, note line 7 of Plate XXI. This is a very slight variation from the Gothic letter

shown on Plate II. Also note line 3 of Plate VII as a similar variation of Gothic.

Ornamentation may take the shape of extraneous features just mentioned, varying the contour shapes and directions of stems of letters, or of embellishing the body of stems, within the contour. The last is a form of ornamentation but little used in this country to-day, and is to be sharply distinguished from that illustrated in imported books of alphabets. On Plate XX in the word *Actor* we see an example of how modern ornamentation runs when it is used. The ornament has very little characteristic interest of its own, but only as it lends a variety to the body of the letters; in other words, it does not partake of the floral or scroll form. Could any addition in the way of ornamentation improve the word "Power" in the first example on the plate? The answer is likely to be that its force would be destroyed if it were ornamented.

In choosing an ornamental letter for a design the artist's taste in fitting the letter to its purpose is the only safe rule. Ornamentation makes interest, but at the sacrifice, generally, of force. Design lettering, it is true, may in itself consist of ornament, that is, the piece of work when done may consist of ornament in which the letters can properly be subservient and not necessarily very legible; they need to be unravelled like other intricacies of the design. The discussion of this highly artistic class of lettering, however, is not properly within the scope of this work.



Between the extremely plain advertising lettering and the ornamental lettering just spoken of there are infinite grades, and each should be suited to its requirements.

As to varying the contour shapes and directions of stems of letters also, there is almost no limit except that set by the requirements of legibility and the preservation of type style, and this is the field in which the beginner is encouraged to practice at first in assaying design. As examples of a few of the more conservative variations of this character, note the alphabets shown on Plates XVII and XXI; these will afford suggestions for him. These variations, further, in addition to preserving type style, cannot be concerned alone with the single isolated letter, but should lend unity to the effect of whatever is comprehended in the line; simply prolonging the free ends of letters, for example, the H, N, etc., at random, does not constitute design.

### 53. Open- and Closed-body Letters.

A form of letter often used, particularly by beginners, is an open-body letter like 4 on Plate XVIII or as the word *Actor* on Plate XX would be without the variation within its contour. There seems to exist an impression that it is easy to make. As a form to use in design it is very useful if properly applied, but it is a mistake to think that it is easily drawn when done well; it is one of the difficult forms, because both sides of the contour line have to be considered in the drawing.

It is not by any means as strong in effect, unless color be used, as a solid-body letter of equal weight would be; therefore in using it among this latter class due account has to be taken of this fact. But if time in execution is ample, most excellent combinations with black-faced letters can be made, and a group of such lettering possesses more interest than one with either used alone.

#### 54. The Limitations of Letters.

Letter forms are not standard and fixed, but they have, on the other hand, certain more or less well defined limits, governed by usage and public demands, as much as anything else, which it is well for the designer to keep clearly in mind and respect if he wishes to be successful in his results.

The preservation of type style and legibility are two of these limits. A violation of these is equally as offensive as bad handling. It requires some knowledge, however, of letter forms in general to be thoroughly conversant with the conditions governing type style. Slight violations of this may not be noticed by the uninitiated and classified as such, but it is quite likely to give to him a general impression of weakness in the design.

Letters have a certain character too, each its own. In all the variations which may be indulged in this must be preserved. Let us be specific. Take a Gothic **A** to start with. We find the top cut off a little; we also find it still further squared off, as the **A** in the word *Mas-*

ters of Plate XX or No. 7 on Plate XXI; but if the top is broadened too far, relative to the spread of the legs, the character of the letter is destroyed, it ceases to appear to be an A. Again, take C; the curve may be flattened and the ends cut off shorter and shorter, as the C in the word *essence* of Plate XX, but it is still a C, whereas if the round form is kept but the ends of the curves be allowed to overlap each other, the character is gone, it ceases to be a legible C. Consider the case of enlarging the serifs on a Roman letter, before alluded to. Fig. 9 shows how the whole character of the letter

Fig. 9  
**ALTER**  
**ALTER**

is changed by making the serifs tangent to the stems further down their length. It is shown in two stages of evolution. The lower line is no longer the Roman letter. Certain considerations, such as these, govern all letters, and they even extend their influence into the realm of ornamental design lettering.

There are certain limits, too, beyond which letters will be weakened, a certain *strength* of character gone. Strong contrasts between sizes or weights of body in groups of letters will tend to weaken some of them, whereas, if used alone, they might not be weak. Stability

in the shape of individual letters, before spoken of, has its limits, and if exceeded conduces to weakness in the effect; for example, the cross-bar of the **H** may be elevated to any reasonable extent above the center, but the moment it is lowered it becomes weakened. Again, take the **B**, by making the lower lobe the smaller, a weaker letter is sure to result; its one limit then lies in the fact that the lower lobe must be equal to or greater than the upper.

The limit set in varying the proportions of letters, together with weight of body and that set in spacing, has been before stated to be that of legibility. The author remembers an old form of puzzle consisting of words elongated in height to many times their width and printed over each other at right angles. If one inclines the printed matter so that it is foreshortened, then it can be read. Letters should be readable without inclining the page. Spacing can be reduced to the width of a fine line provided the letters do not touch each other and thus destroy legibility, the exception to be noted of course in the case of ornamental and designed letters such as those on Plate XVIII.

## CHAPTER VII.

### MECHANICAL AIDS TO LETTERING.

#### 55. General Statement.

While the correct way to letter satisfactorily is undoubtedly free-hand, yet mechanical treatment may be sometimes necessary, or the draftsman, not having experience enough or skill in free-hand work, finds himself compelled to resort to mechanical treatment.

Quite a good deal of effort has been expended in devising handy means of laying out letters mechanically. They are fairly successful for the purpose, it must be confessed. The construction of certain alphabets in Prof. Jacoby's book can be very easily followed, although he himself advocates rendering them free-hand. The trouble with these various methods is that they fail signally when letters are to be made quite small, as they generally are in practical work.

Aids mechanically may take several forms. The letters may be laid out with the rule and compass in pencil, copied in ink, or they may be sketched free-hand in pencil and copied mechanically, or, still further, the letters may be stamped from rubber stamp or printing-press and worked over with ink free-hand.

## 56. Practical Points about Executing a Ruled Letter.

A method of lettering by mechanical treatment but with least dependence upon the instruments is to lay out the work free-hand in pencil, inking it with the ruling-pen and compass; it is very common practice among mechanical draftsmen. In this class of ruled letter too much care cannot be expended upon the pencil layout; the better the draftsman, therefore, the better the letter even if ruled.

When letters are thus laid out in pencil some consistent plan should be followed in copying them in ink, that is, a plan which will insure correct interpretation of the pencil-lines. This is more essential in the case of ruled letters than it is for free-hand treatment, because when ruling is in progress it is very difficult to interpret the letter shapes and to correct through the handling any defects in the forms; one very naturally depends upon the straight-edge and ruling-pen to do the work correctly. In the curved forms, the bane of the inexperienced, extreme care in the centering of the compass is in order; in work of any size it is probably safest to lay out the center in the penciling with straight lines crossing one another and a small free-hand circle to mark the intersection so that it can easily be found. It is perhaps best to copy a free-hand curve with located centers, in this way, than it is to lay out the curves entirely by mechanical methods in pencil, because the former permits of slight adjustments.

The same advice can also here be given that was given for free-hand treatment in the matter of building up

the Gothic letter of moderately heavy body by fine contour lines, in preference to adding to the first stroke until it acquires the proper weight. If a contour line is used, there is chance before filling in, by whatever method, to inspect the forms and correct before too much careful work has to be rubbed out. In filling in such forms, a brush or the writing-pen is probably more expeditious than the ruling-pen; there is also in the former less likelihood of blotting.

It is an open question whether any person with ordinary capacity may not make of himself, with well-directed and persistent effort, an acceptable free-hand letterer. It is quite probable that many fail because of a hastily formed impression that they cannot do it and from that time on depend entirely upon some mechanical treatment. Dependence upon such gradually spoils whatever latent capacity may exist. It is to be strongly urged upon the timid to try to acquire a facility with the pencil and pen free-hand. This may be accomplished, if time for separate practice is not available, by cutting away gradually from dependence upon mechanical aids; keep the mind continually alive to the proper development of the letter forms; gradually use more and more free-hand treatment; it will be surprising how this sort of facility will come with practice.

## **57. Drafting-room Practice in the Use of Stock Titles Reproduced in Blue-prints, etc.**

Since careful lettering takes time and time is money,

it has become customary in many manufacturing and engineering establishments to use a stock form for the lettering which is to appear repeatedly upon the drawings, the main title for example. The title is printed upon a piece of tracing-cloth to be inserted beneath the drawing when a blue-print is made, or it is printed in good black ink on the tracing-cloth by means of a regular printing-press, or still again, what is more common, the tracing is stamped with the required lettering, using a rubber stamp for the purpose. The draftsman goes over this afterwards with the pen, copying the stamped letters; it is a matter occupying but a few moments' time, because the ink from the stamp guides and absorbs up to its limits the India ink from the pen, rendering careful contouring unnecessary. To illustrate these forms of reproducing lettering Plates XIII and XIV are introduced. The first one, on Plate XIV, shows a title printed from the printing-press directly upon the cloth. It contains so much matter that a considerable amount of time would be consumed in laying it all out free-hand. Number 1 on Plate XIII is also one of this class. Number 2 on the same plate shows a mechanically drawn letter throughout. As a time-saver the stamping process is thoroughly successful.

### 58. Lettering Triangles.

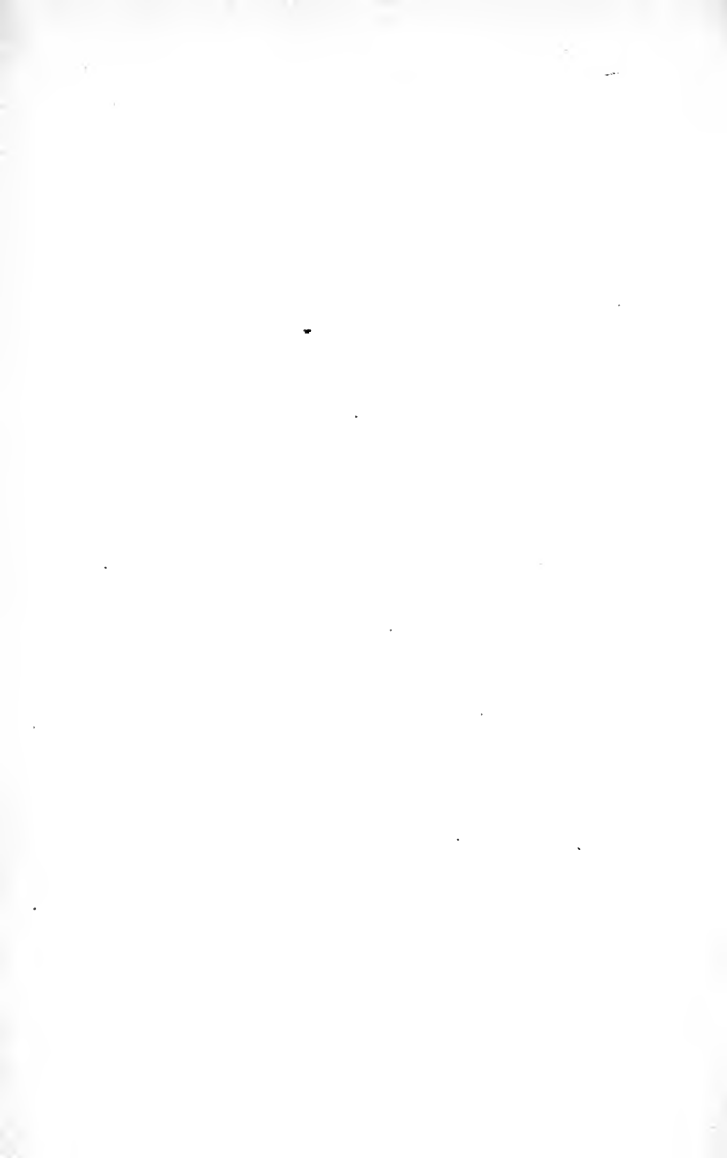
It may be thought by some that this survey would not be complete without some mention of the lettering triangles in common use. These, also, properly come



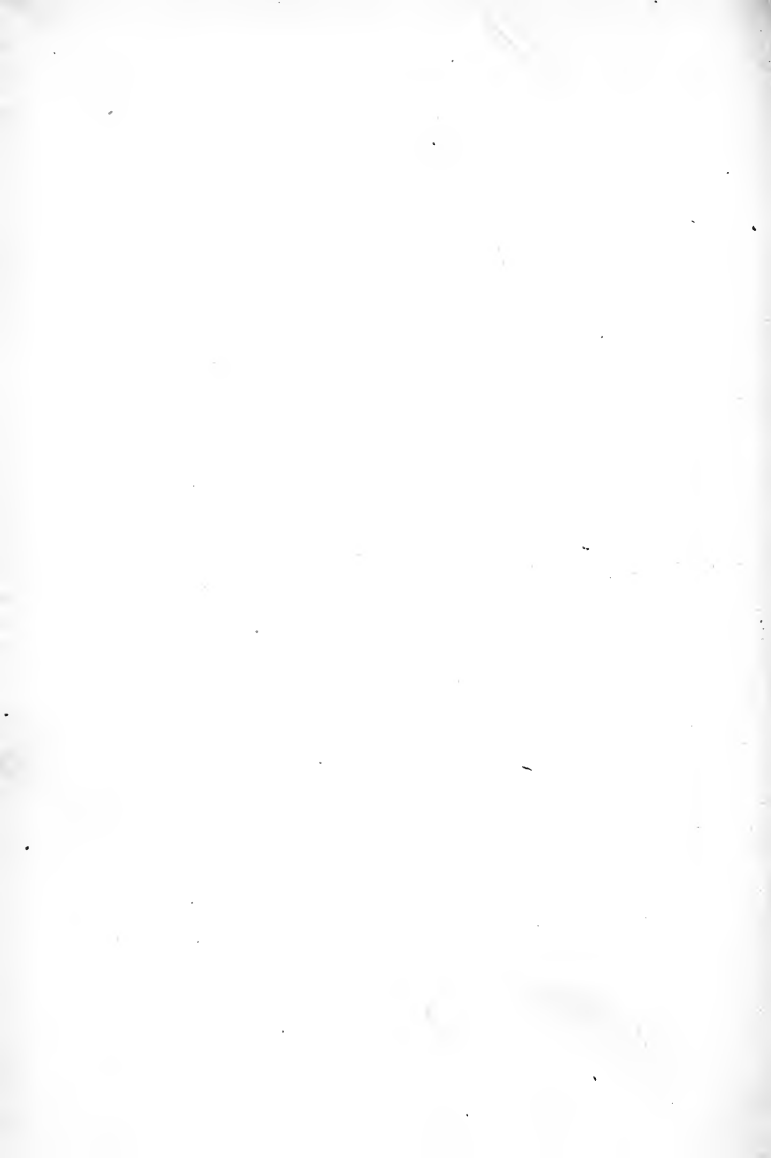
under the head of mechanical aids. They can be obtained at the stores, and consist of a combination of angles suited to the various inclinations in any given alphabet, the A, K, N, etc. They are regarded by some as quite useful. Their range is limited, however, being suitable only for certain proportions of letters near the standard; letters of very different proportions grow awkward in their form if made with them. Encouragement should not be given to these aids; the usual  $30^{\circ}$  and  $60^{\circ}$  and the  $45^{\circ}$  triangles will be found to give better service, the unaided eye being depended upon to scale inclinations.









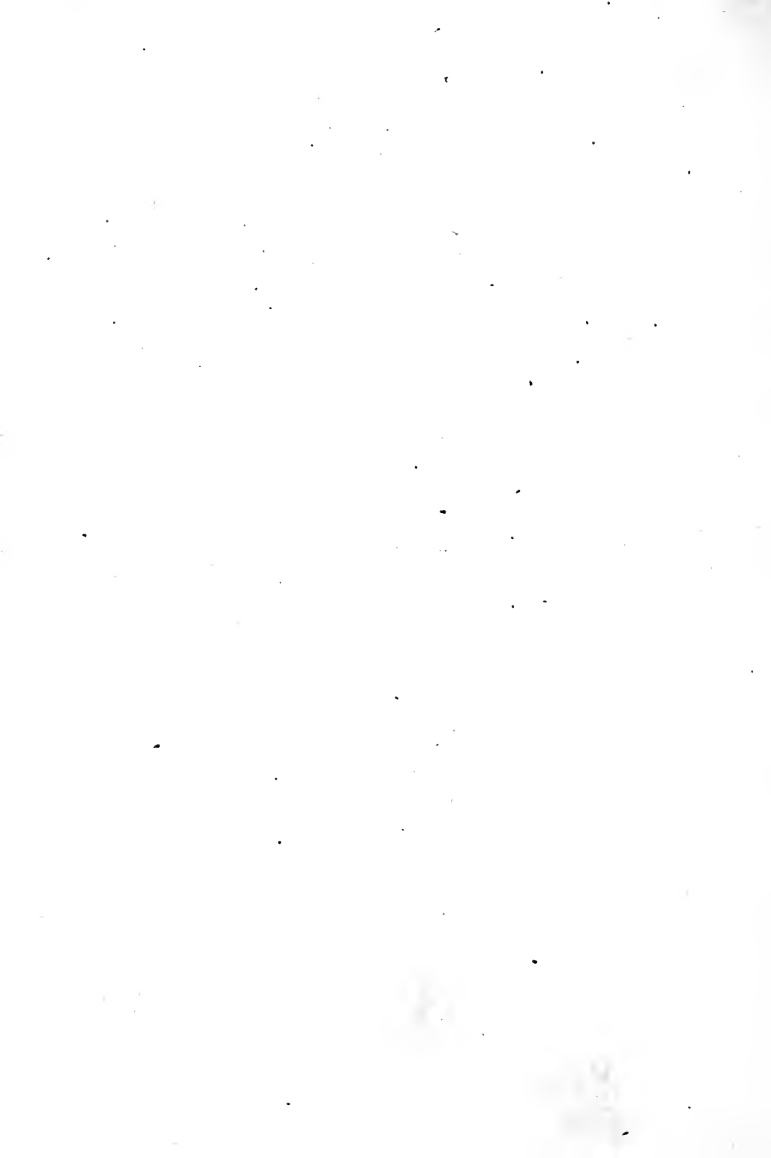


MODERN ROMAN LARGE.

6 A B C D E F G H I  
 $\leftarrow 5\frac{1}{2} \rightarrow$   $\leftarrow 5\frac{1}{4} \rightarrow$   $\leftarrow 5\frac{3}{4} \rightarrow$   $\leftarrow 5\frac{1}{2} \rightarrow$   $\leftarrow 4\frac{3}{4} \rightarrow$   $\leftarrow 5\frac{3}{4} \rightarrow$   $\leftarrow 5 \rightarrow$   $\leftarrow 5 \rightarrow$   $\leftarrow 5\frac{1}{4} \rightarrow$

6 J K L M N O P Q R  
 $\leftarrow 4\frac{1}{4} \rightarrow$   $\leftarrow 5\frac{1}{2} \rightarrow$   $\leftarrow 4\frac{1}{2} \rightarrow$   $\leftarrow 6 \rightarrow$   $\leftarrow 4\frac{1}{2} \rightarrow$   $\leftarrow 6 \rightarrow$   $\leftarrow 4\frac{3}{4} \rightarrow$   $\leftarrow 6 \rightarrow$   $\leftarrow 5\frac{1}{2} \rightarrow$

6 S T U V W X Y Z &  
 $\leftarrow 5\frac{1}{4} \rightarrow$   $\leftarrow 5\frac{1}{2} \rightarrow$   $\leftarrow 4\frac{3}{4} \rightarrow$   $\leftarrow 5\frac{1}{2} \rightarrow$   $\leftarrow 8 \rightarrow$   $\leftarrow 5\frac{1}{2} \rightarrow$   $\leftarrow 5\frac{1}{2} \rightarrow$   $\leftarrow 5 \rightarrow$   $\leftarrow 6 \rightarrow$





MODERN GOTHIC, LARGE.

6 A B C D E F G H I

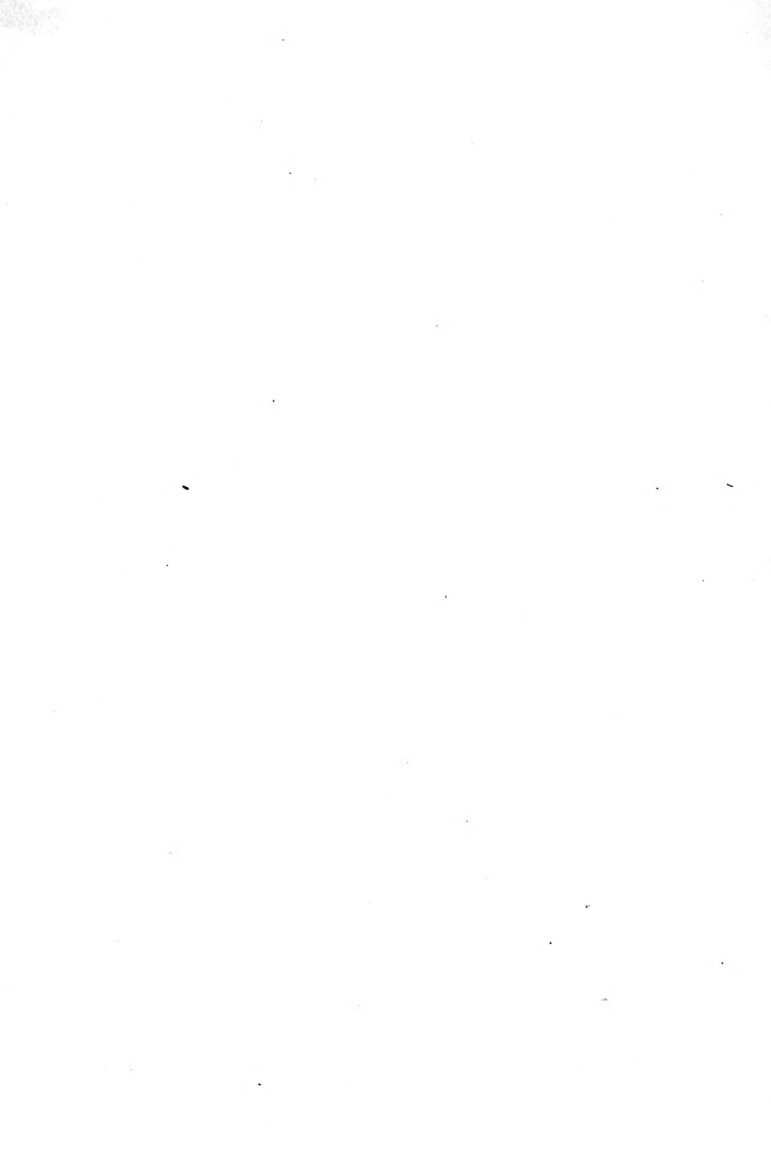
Diagram showing the construction of letters A through I in Modern Gothic, Large. Each letter is shown on a set of four horizontal guidelines (top, x-height, descender, and baseline). Arrows and numbers indicate the stroke order and width measurements for each letter. For example, 'A' has a width of 6½ and a height of 5¼. 'I' has a width of 1½ and a height of 5¾.

6 J K L M N O P Q R

Diagram showing the construction of letters J through R in Modern Gothic, Large. Each letter is shown on a set of four horizontal guidelines. Arrows and numbers indicate the stroke order and width measurements. For example, 'J' has a width of 4¼ and a height of 5½. 'R' has a width of 5¾ and a height of 5¾.

6 S T U V W X Y Z & .

Diagram showing the construction of letters S through Z, the ampersand (&), and the period (.) in Modern Gothic, Large. Each letter is shown on a set of four horizontal guidelines. Arrows and numbers indicate the stroke order and width measurements. For example, 'S' has a width of 5¼ and a height of 5½. 'Z' has a width of 5 and a height of 5. The ampersand (&) has a width of 5½ and a height of 5½.



ROMAN & GOTHIC SMALL & NUMERALS.

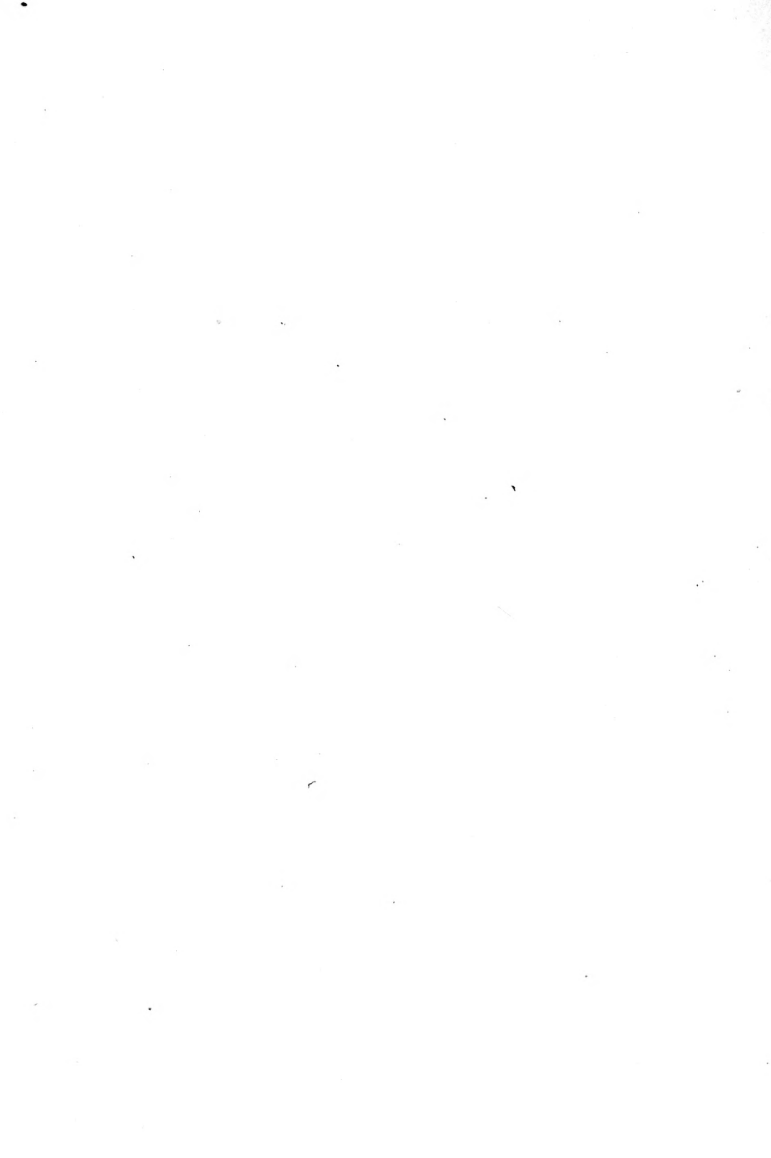
a b c d e f g h i j k l m n o

p q r s t u v w x y z.

a b c d e f g h i j k l m n o

p q r s t u v w x y z.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24



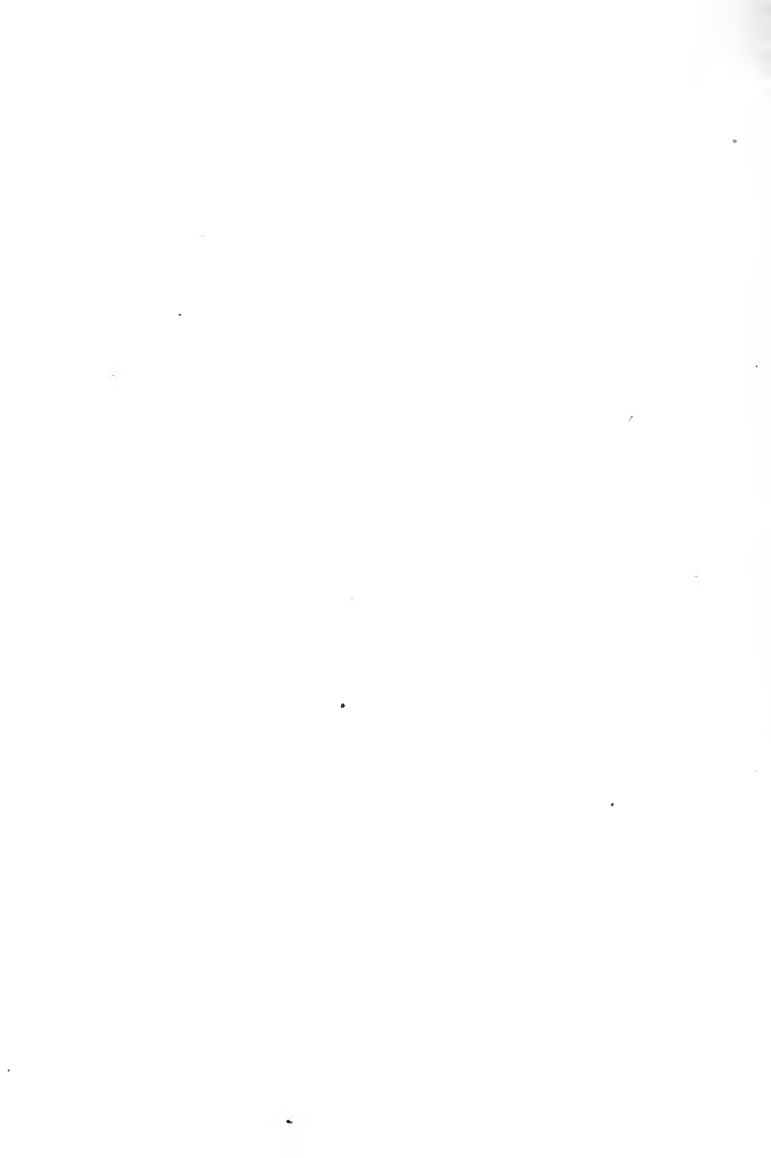
ITALICIZED ROMAN & GOTHIC.

*ABDGKMRSWX*

*ABDGKMRSWX*

*abeghmwy—abgmw*

*2345678 2568*



STUMP WRITING.

*abcdefghijklmnopqrstuvwxyz*

*123456789*

SINGLE LINE GOTHIC.

ABCDEFGHIJKLMNOPQRSTUVWXYZ

abcdefghijklmnopqrstuvwxyz 1234567890

ABCDEFGHIJKLMNOPQRSTUVWXYZ

abcdefghijklmnopqrstuvwxyz 1234567890





Hydraulic Machinery. 24 inch.  
 Double Hoisting Drum.  $3\frac{1}{2}$  feet.  
 A Handy Working Ratio,  $\frac{2}{3}$ .  
 A Standard & Easy Letter. 5".  
*Never Copy, Be Original. 36.*

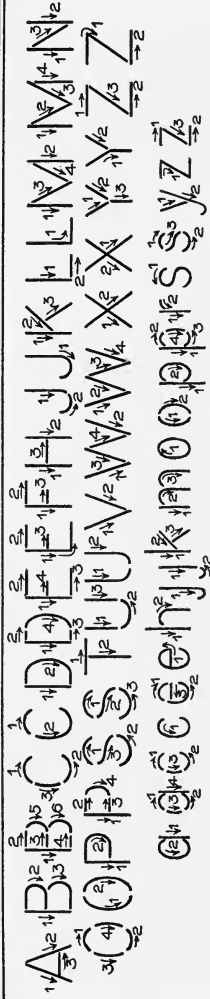
Shows letters formed into words, also various ratios of capitals and small letters as follows:— 1, the standard, is 1 to .6, 2 is 1 to .5, 3, 4 and 5 are 1 to  $\frac{2}{3}$ . The numerals in 2, 3 and 4 are made slightly shorter than the standard also proportionately lighter body. Weight of body is the same relation to the height throughout, the normal width of letters is 5 units as on Plates 1, 2 and 3.



**Examples in SPACING Words.  
Examples in SPACING Words.  
DESIGN Your Letters and SPACING.  
The WEST Patent Compression COUPLING.  
Don't use DULL or POOR TOOLS.  
Shows how NARROW SPACING Compresses.  
LARGE SPACING Requires Room.**

EXAMPLES IN PROPORTIONING AND IN SPACING LETTERS. Nos. 1 and 2 show the effect of the same matter treated in Roman and in Gothic letters with the same spacing and proportioning, i.e., normal,  $2\frac{1}{2}$  units. Spacing of No. 3 is 2 units. Nos. 4 and 5 have the same normal space of  $1\frac{1}{2}$  units but differ in proportions. Nos. 6 and 7 have the same proportion of letters but differ in spacing, the first being about  $\frac{1}{2}$  unit while the second is about  $3\frac{1}{2}$  units.





A, BCDEFHNPSTW, BDHP, BGR, adhiklm

ntuy, abcdeghkmnpq, abeghmnop, afgs. and there in letters im-

ABDFGKMS;

ABD FGKMS, can be used either compressed or extended. The second group of small letters looks better extended.

ABCDEGHKMNP SWZ.

abcdefghijklmnopqrstuvwxyz.

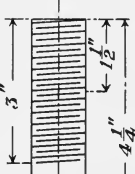
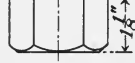
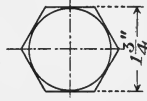
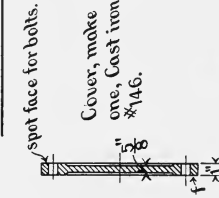
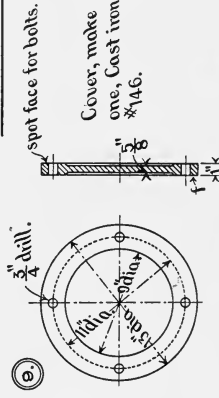
These styles are quite often inclined.



STYLES SUITABLE FOR WORKING DRAWINGS.

1. ABDKMQRSXY, abcdefghjkmoprstwy. 2356. A beginner can handle this style.
2. ABCDEFGHJKLMQRSTWX, abcdefghjkmoprstwy. 23456.
3. ABDEKLMTWX, abefhkmpr
4. ABDEKLMTWX, abefhkmpr. Choose the style you can do most easily.
5. ABDEGHKMRSTWX, abefghjkmprty.
6. ABDEGHLMRSTWX, abefghjkmprty.
7. ABCDEGHJKLMRSTWX, abcdefghjkmprtywz. 2'-4 in. dia.
8. ABCDEGHJKLMRTWX, abfghjkmprtywz. After choosing stick to it.

Drill  $1\frac{3}{4}$ " except where  $1\frac{3}{4}$ " fitted bolts are used  
For fitted bolts see bed drawing 7-B-5.  
Be careful to drill to match bosses on bed.



4 Bolts. Cut threads on two of them for  $1\frac{1}{2}$ " as shown.





Corliss<sup>7</sup> Engines<sup>14</sup>  
 manufactured by<sup>14</sup>  
 Hewes, Norris & Co.<sup>14</sup>  
 Williamsport, Pa.<sup>12</sup>  
 Oct. 25-190-<sup>9</sup> H. P. Bates, Eng.<sup>10</sup>

CORLISS ENGINES  
 MANUFACTURED BY  
 HEWES, NORRIS & CO.  
 WILLIAMSPORT, PA.

OCT. 25, 190- H. P. Bates, Eng.

CORLISS ENGINES.  
 MANUFACTURED BY  
 HEWES, NORRIS & CO.  
 WILLIAMSPORT, PA.  
 OCT 25, 190- H. P. Bates. Eng.

CORLISS ENGINES  
 MANUFACTURED BY  
 HEWES, NORRIS & CO.  
 WILLIAMSPORT, PA.  
 OCT 25, 190- H. P. Bates, Eng.

CORLISS ENGINES  
 MANUFACTURED BY  
 HEWES, NORRIS & CO.  
 WILLIAMSPORT, PA.

OCT. 25, 190- H. P. Bates, Eng.

Stages 2, 3 & 4 are supposed to be in pencil. The 4th. stands for a very careful pencilling to be followed with ink, several letters in each line are finished in treatment either with pencil or ink, so that the proper effect of the whole may be suggested.



① <sup>a</sup> DIAGRAM OF PLANT  
FOR THE  
<sup>b</sup> DISPOSAL OF SEWAGE  
<sup>c</sup> CITY OF ITHACA  
BUILT BY THE  
<sup>d</sup> SOUTHEND ENGINE & MACHINE CO.  
<sup>e</sup> PHILA. PENNA.

③ <sup>a</sup> DIAGRAM  
OF  
<sup>b</sup> PLANT  
<sup>c</sup> FOR THE DISPOSAL OF SEWAGE  
OF THE  
<sup>d</sup> CITY OF ITHACA  
BUILT BY THE  
<sup>e</sup> SOUTHEND ENGINE & MCH. CO.  
<sup>f</sup> PHILADA., PENNA.

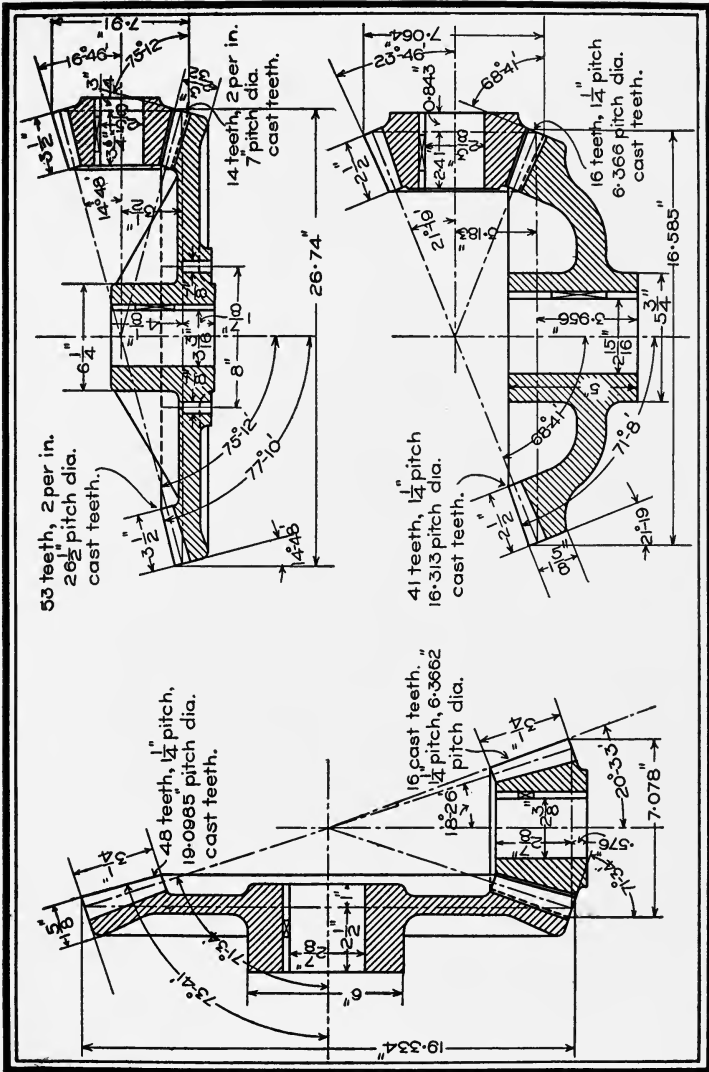
⑤ <sup>a</sup> DIAGRAM OF PLANT  
FOR THE DISPOSAL OF SEWAGE  
OF THE  
<sup>c</sup> CITY OF ITHACA  
Built by the  
<sup>d</sup> Southend Engine & Machine Co.  
<sup>e</sup> Philada., Penna.

② <sup>a</sup> DIAGRAM OF PLANT  
FOR THE  
<sup>b</sup> DISPOSAL OF SEWAGE  
<sup>c</sup> CITY OF ITHACA  
BUILT BY THE  
<sup>d</sup> SOUTHEND ENGINE & MACHINE CO.  
<sup>e</sup> PHILA. PENNA.

④ <sup>a</sup> DIAGRAM OF PLANT  
FOR THE DISPOSAL OF SEWAGE  
OF THE  
<sup>c</sup> CITY OF ITHACA  
BUILT BY THE  
<sup>d</sup> SOUTHEND ENGINE & MCH. CO.  
<sup>e</sup> Philada., Penna.

*Plate shows how slight changes alter the effect.  
Letters in 1 & 2 are same height and proportion except  
line (c). Prominence effected by weight of letters.  
Letters in three principal lines in 3 are of the same  
height. Prominence effected by proportion and  
weight. 4 gives effect of large title by narrow  
letters in all but one of the principal lines. 5 is  
an example of even more off-hand treatment  
than the others. Inclined, shows errors less.*







I.  
**AMERICAN BRIDGE CO.,**

EDGEMOOR PLANT.

A. B. Co. Contr. No. .... In Charge of Wilson.

Made by J.C. .... Date 9/25/00 Rev. 9/30

Checked by E.K. .... Date 9/27/00 Rev. ....

**ORDER No.** ..... **SHEET No.** 12

II  
FURNACE "E-F"  
**FRONT COLUMN FOR ORE BIN**

COLORADO FUEL & IRON COMPANY  
PUEBLO COLO.

Scale 1"=1'  
AMERICAN BRIDGE COMPANY  
PITTSBURGH PA  
SHIFFLER PLANT

III.  
Rear Column  
For  
Ore Bins - Furnace "E"  
Colorado Fuel & Iron Company  
Pueblo, Colo.

American Bridge Company  
Shiffler Plant  
Pittsburg, Pa. Jan. 21 - 1902





I.

# THE BROWN HOISTING MACHINERY COMPANY,

INCORPORATED.

CLEVELAND, OHIO, U. S. A.

THE FAYETTE BROWN PATENT FURNACE HOIST, WITH THE A. E. BROWN PATENT  
AUTOMATIC STOCK DISTRIBUTOR, AS DESIGNED FOR THE

NEW JERSEY ZINC COMPANY,

NEW YORK.

II.

# EIGHT WHEEL SHAARE FLOW ASSEMBLY <sup>and</sup> DETAILS FRAMING.

Facsimile reproductions from blue prints. No.1 is a form printed on the  
original tracing to save draftsman's time. No.2 was made rapidly with  
the ruling pen.



**LETTERING** *U.S. Geological Survey.*

**CIVIL DIVISIONS**

*States, Counties, Townships, Capitals and Principal Cities.*

ABCDEF GHIJKL MNOPQR  
STUVWXYZ

*Towns and Villages*

abcde fghij klmnopqrstuvwxyz

**HYDROGRAPHY**

*Lakes, Rivers and Bays*

ABCDEF GHIJKL MNOPQR  
STUVWXYZ

*Creeks, Brooks, Springs, small Lakes, Ponds, Marshes and Glaciers.*

abcde fghij klmnopqrstuvwxyz

**PUBLIC WORKS**

*Railroads, Tunnels, Bridges, Ferries, Wagon-roads, Trails, Fords and Dams.*

ABCDEF GHIJKL MNOPQRST UVWXYZ

**CONTOUR NUMBERS**

1234567890 1234567890



# *U.S. Geological Survey.* **BOUNDARY LINES**

## **MARGINAL LETTERING**

ABCDEFGHIJKLMNOPQRSTUVWXYZ

abcdefghijklmnopqrstuvwxyz

1234567890

*Thickness of letter 4 of height.*

*Slope of letter 3 parts of base to 8 of height.*



*State Line*

*County "*

*Township"*

*Reservation Line*

*Land Grant Line*

*City, Village and Borough Line*

*U.S. Township Line*

*U.S. Section Line*

## **HYP SOGRAPHY**

*Mountains, Plateaus, Lines of Cliffs and Canyons.*

ABCDEFGHIJKLMNOPQRSTUVWXYZ

*Peaks, small Valleys, Canyons. Islands and Points.*

abcdefghijklmnopqrstuvwxyz

*State*

NEW YORK  
VERMONT

BOUNDARY  
LINE

*County*

HAMILTON CO.  
UNION CO.

BOUNDARY  
LINE

*Lettering on  
Boundary Lines*



ABCDEF GHIJKLMNOQRSTUVWXYZ

L.F. DAY

ABCDEF GHIJKLMNOPQRSTUVWXYZ. abcde

H.S. JACOBY.

fghijklmnopqrstvwxyz.

Clutch coupling.

ABCDEFGHIJKLMNORŠWY. abefghij

J.C.L. FISH.

kmqrzy. These holes to be spaced as shown.

ABCDEFGHIJKLMNPRŠUVWXY.

G.W. CASEY.

BCDEFJMRŠTUY abdefghikmrp  
sluwy. 4 of these wanted, 2 right, 2 left.

J.C.L. FISH.





① JERSEY CITY &

· PASSAIC R. R. CO.

· GENERAL PLAN OF STATION.

· SHOWING PROPOSED.

· TERMINAL FACILITIES.

SCALE 20 FT. = ONE INCH.

③ RESIDENCE FOR MR. G. ALLEN, ITHACA, N.Y.  
DETAILS OF DRESSERS.

C. A. MARTIN, ARCH'T., ITHACA, APR. 5, 1901.

Scale  $\frac{3}{4}$ " to 1 foot.

DRAWING NO 104-32.

② PLANS FOR PROPOSED PUBLIC LIBRARY.  
SUBMITTED IN COMPLIANCE WITH THE REQUEST OF THE COMMON COUNCIL OF ATHENS, ILL. BY WALKER & JAY ARCHTS. APR. 14, 1901.

④ DETAILS OF -

- EAST DOORS

⑤ Front Elevation  
of Stairway.



# EFFECT OF REDUCTION FREE BRUSH LETTER

*Blurred corners  
like these look worse  
in reduction, also irreg-  
ular and ragged lines.*

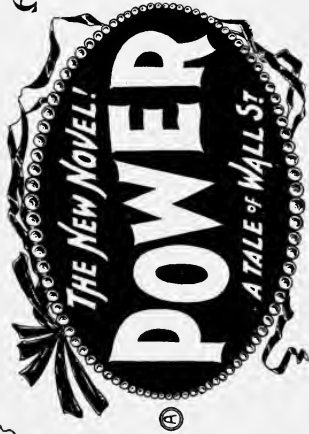
RE

*reduce to  $2\frac{3}{8}$  inches*

*Blurred corners  
like these look worse  
in reduction, also irreg-  
ular and ragged lines.*



# Advertising Styles



**AFSROG**

© The Very Essence of Excellence and Wit.

**MYA STARRS.**





VARIOUS DESIGNED LETTERS.

ABC FGLMP PRX.— ARCHITECTURAL.  
I Roman. 150 to 300 A.D.

ABC OEC JKMQ UW— ORNAMENT.  
II Mm's. 10th. Cent.

abc efghmopqstuy— Old Roman.  
III Italian. 1570.

ACCGH JKMN RSTW X abefghjkmptxy.  
IV English. 1697.

ABFGJMRSTW abgmp rwy— Neatness.  
V French.

ABCEFGJMN RSTW— ELEGANT.  
VI Des'g by L.F. Day.

BCDGKMP SW— SIMPLE TREATMENT.  
VII Des'g by J.W. Weekes.

ABCDEF GHIKΘΠPSUVWXY.  
VIII Des'g by W.J. Pearce.





MODERN ROMAN-GOTHIC LETTERS.

A B C D E F G H I  
J K L M N O P Q R  
S T U V W X Y Z &  
a c e i m n o r t b d f h k l  
g j p q y s u v w x z.  
1 2 3 4 5 6 7 8 9.



OLD ROMAN LETTERS.

A B C D E F G H I J K

L M N O P Q R S T V

W X Y Z. POPVLAR.

a b c d e f h i k l m n o r s t

g j p q u v w x y z. Modern.

C E F G M N P R S T.







# SHORT-TITLE CATALOGUE

OF THE  
PUBLICATIONS

OF  
JOHN WILEY & SONS,

NEW YORK.

LONDON: CHAPMAN & HALL, LIMITED.

ARRANGED UNDER SUBJECTS.

Descriptive circulars sent on application. Books marked with an asterisk are sold at *net* prices only, a double asterisk (\*\*) books sold under the rules of the American Publishers' Association at *net* prices subject to an extra charge for postage. All books are bound in cloth unless otherwise stated.

## AGRICULTURE.

Armsby's Manual of Cattle-feeding. . . . .	12mo,	\$1 75
Principles of Animal Nutrition. . . . .	8vo,	4 00
Budd and Hansen's American Horticultural Manual:		
Part I.—Propagation, Culture, and Improvement. . . . .	12mo,	1 50
Part II.—Systematic Pomology. . . . .	12mo,	1 50
Downing's Fruits and Fruit-trees of America. . . . .	8vo,	5 00
Elliott's Engineering for Land Drainage. . . . .	12mo,	1 50
Practical Farm Drainage. . . . .	12mo,	1 00
Green's Principles of American Forestry. . . . .	12mo,	1 50
Grotenfelt's Principles of Modern Dairy Practice. (Woll.) . . . . .	12mo,	2 00
Kemp's Landscape Gardening. . . . .	12mo,	2 50
Maynard's Landscape Gardening as Applied to Home Decoration. . . . .	12mo,	1 50
Sanderson's Insects Injurious to Staple Crops. . . . .	12mo,	1 50
Insects Injurious to Garden Crops. ( <i>In preparation.</i> )		
Insects Injuring Fruits. ( <i>In preparation.</i> )		
Stockbridge's Rocks and Soils. . . . .	8vo,	2 50
Woll's Handbook for Farmers and Dairymen. . . . .	16mo,	1 50

## ARCHITECTURE.

Baldwin's Steam Heating for Buildings. . . . .	12mo,	2 50
Berg's Buildings and Structures of American Railroads. . . . .	4to,	5 00
Birkmire's Planning and Construction of American Theatres. . . . .	8vo,	3 00
Architectural Iron and Steel. . . . .	8vo,	3 50
Compound Riveted Girders as Applied in Buildings. . . . .	8vo,	2 00
Planning and Construction of High Office Buildings. . . . .	8vo,	3 50
Skeleton Construction in Buildings. . . . .	8vo,	3 00
Briggs's Modern American School Buildings. . . . .	8vo,	4 00
Carpenter's Heating and Ventilating of Buildings. . . . .	8vo,	4 00
Freitag's Architectural Engineering. 2d Edition, Rewritten. . . . .	8vo,	3 50
Fireproofing of Steel Buildings. . . . .	8vo,	2 50
French and Ives's Stereotomy. . . . .	8vo,	2 50
Gerhard's Guide to Sanitary House-inspection. . . . .	16mo,	1 00
Theatre Fires and Panics. . . . .	12mo,	1 50
Holly's Carpenters' and Joiners' Handbook. . . . .	18mo,	75
Johnson's Statics by Algebraic and Graphic Methods. . . . .	8vo,	2 00

<b>Kidder's Architect's and Builder's Pocket-book. Rewritten Edition.</b>	16mo, mor.,	5 00
<b>Merrill's Stones for Building and Decoration.</b>	8vo,	5 00
<b>Non-metallic Minerals: Their Occurrence and Uses.</b>	8vo,	4 00
<b>Monckton's Stair-building</b>	4to,	4 00
<b>Patton's Practical Treatise on Foundations.</b>	8vo,	5 00
<b>Peabody's Naval Architecture.</b>	8vo,	7 50
<b>Richey's Handbook for Superintendents of Construction.</b> ( <i>In press.</i> )		
<b>Sabin's Industrial and Artistic Technology of Paints and Varnish.</b>	8vo,	3 00
<b>Siebert and Biggin's Modern Stone-cutting and Masonry.</b>	8vo,	1 50
<b>Snow's Principal Species of Wood.</b>	8vo,	3 50
<b>Sondericker's Graphic Statics with Applications to Trusses, Beams, and Arches.</b>	8vo,	2 00
<b>Towne's Locks and Builders' Hardware.</b>	18mo, morocco,	3 00
<b>Wait's Engineering and Architectural Jurisprudence.</b>	8vo,	6 00
	Sheep,	6 50
<b>Law of Operations Preliminary to Construction in Engineering and Architecture.</b>	8vo,	5 00
	Sheep,	5 50
<b>Law of Contracts.</b>	8vo,	3 00
<b>Wood's Rustless Coatings: Corrosion and Electrolysis of Iron and Steel.</b>	8vo,	4 00
<b>Woodbury's Fire Protection of Mills.</b>	8vo,	2 50
<b>Worcester and Atkinson's Small Hospitals, Establishment and Maintenance.</b>		
<b>Suggestions for Hospital Architecture, with Plans for a Small Hospital.</b>	12mo,	1 25
<b>The World's Columbian Exposition of 1893.</b>	Large 4to,	1 00

## ARMY AND NAVY.

<b>Bernadou's Smokeless Powder, Nitro-cellulose, and the Theory of the Cellulose Molecule.</b>	12mo,	2 50
* <b>Bruff's Text-book Ordnance and Gunnery.</b>	8vo,	6 00
<b>Chase's Screw Propellers and Marine Propulsion.</b>	8vo,	3 00
<b>Craig's Azimuth.</b>	4to,	3 50
<b>Crehore and Squire's Polarizing Photo-chronograph.</b>	8vo,	3 00
<b>Cronkhite's Gunnery for Non-commissioned Officers.</b>	24mo, morocco,	2 00
* <b>Davis's Elements of Law.</b>	8vo,	2 50
* <b>Treatise on the Military Law of United States.</b>	8vo,	7 00
	Sheep,	7 50
<b>De Brack's Cavalry Outpost Duties.</b> (Carr.)	24mo morocco,	2 00
<b>Dietz's Soldier's First Aid Handbook.</b>	16mo, morocco,	1 25
* <b>Dredge's Modern French Artillery.</b>	4to, half morocco,	15 00
<b>Durand's Resistance and Propulsion of Ships.</b>	8vo,	5 00
* <b>Dyer's Handbook of Light Artillery.</b>	12mo,	3 00
<b>Eissler's Modern High Explosives.</b>	8vo,	4 00
* <b>Fiebeger's Text-book on Field Fortification.</b>	Small 8vo,	2 00
<b>Hamilton's The Gunner's Catechism.</b>	18mo,	1 00
* <b>Hoff's Elementary Naval Tactics.</b>	8vo,	1 50
<b>Ingalls's Handbook of Problems in Direct Fire.</b>	8vo,	4 00
* <b>Ballistic Tables</b>	8vo,	1 50
* <b>Lyons's Treatise on Electromagnetic Phenomena. Vols. I. and II.</b>	8vo. each,	6 00
* <b>Mahan's Permanent Fortifications.</b> (Mercur.)	8vo, half morocco,	7 50
<b>Manual for Courts-martial</b>	16mo, morocco,	1 50
* <b>Mercur's Attack of Fortified Places.</b>	12mo,	2 00
* <b>Elements of the Art of War.</b>	8vo,	4 00
<b>Metcalf's Cost of Manufactures—And the Administration of Workshops, Public and Private.</b>	8vo,	5 00
* <b>Ordnance and Gunnery.</b> 2 vols.	12mo,	5 00
<b>Murray's Infantry Drill Regulations.</b>	18mo, paper,	10
<b>Peabody's Naval Architecture.</b>	8vo	7 50



* Phelps's Practical Marine Surveying.....	8vo,	2 50
Powell's Army Officer's Examiner.....	12mo,	4 00
Sharpe's Art of Subsisting Armies in War.....	18mo, morocco,	1 50
* Walke's Lectures on Explosives.....	8vo,	4 00
* Wheeler's Siege Operations and Military Mining.....	8vo,	2 00
Winthrop's Abridgment of Military Law.....	12mo,	2 50
Woodhull's Notes on Military Hygiene.....	16mo,	1 50
Young's Simple Elements of Navigation.....	16mo morocco,	1 00
Second Edition, Enlarged and Revised.....	16mo, morocco,	2 00

### ASSAYING.

Fletcher's Practical Instructions in Quantitative Assaying with the Blowpipe.....	12mo, morocco,	1 50
Furman's Manual of Practical Assaying.....	8vo,	3 00
Lodge's Notes on Assaying and Metallurgical Laboratory Experiments....	8vo,	3 00
Miller's Manual of Assaying.....	12mo,	1 00
O'Driscoll's Notes on the Treatment of Gold Ores.....	8vo,	2 00
Ricketts and Miller's Notes on Assaying.....	8vo,	3 00
Ulke's Modern Electrolytic Copper Refining.....	8vo,	3 00
Wilson's Cyanide Processes.....	12mo,	1 50
Chlorination Process.....	12mo,	1 50

### ASTRONOMY.

Comstock's Field Astronomy for Engineers.....	8vo,	2 50
Craig's Azimuth.....	4to,	3 50
Doolittle's Treatise on Practical Astronomy.....	8vo,	4 00
Gore's Elements of Geodesy.....	8vo,	2 50
Hayford's Text-book of Geodetic Astronomy.....	8vo,	3 00
Merriman's Elements of Precise Surveying and Geodesy.....	8vo,	2 50
* Michie and Harlow's Practical Astronomy.....	8vo,	3 00
* White's Elements of Theoretical and Descriptive Astronomy.....	12mo,	2 00

### BOTANY.

Davenport's Statistical Methods, with Special Reference to Biological Variation.....	16mo, morocco,	1 25
Thomé and Bennett's Structural and Physiological Botany.....	16mo,	2 25
Westermaier's Compendium of General Botany. (Schneider.).....	8vo,	2 00

### CHEMISTRY.

Adrianse's Laboratory Calculations and Specific Gravity Tables.....	12mo,	1 25
Allen's Tables for Iron Analysis.....	8vo,	3 00
Arnold's Compendium of Chemistry. (Mandel.).....	Small 8vo,	3 50
Austen's Notes for Chemical Students.....	12mo,	1 50
* Austen and Langworthy. The Occurrence of Aluminium in Vegetable Products, Animal Products, and Natural Waters.....	8vo,	2 00
Bernadou's Smokeless Powder.—Nitro-cellulose, and Theory of the Cellulose Molecule.....	12mo,	2 50
Bolton's Quantitative Analysis.....	8vo,	1 50
* Browning's Introduction to the Rarer Elements.....	8vo,	1 50
Brush and Penfield's Manual of Determinative Mineralogy.....	8vo,	4 00
Classen's Quantitative Chemical Analysis by Electrolysis. (Boltwood.)....	8vo,	3 00
Cohn's Indicators and Test-papers.....	12mo,	2 00
Tests and Reagents.....	8vo,	3 00
Craft's Short Course in Qualitative Chemical Analysis. (Schaeffer.)....	12mo,	1 50
Dolezalek's Theory of the Lead Accumulator (Storage Battery). (Von Ende).....	12mo,	2 50
Drechsel's Chemical Reactions. (Merrill.).....	12mo,	1 25
Duhem's Thermodynamics and Chemistry. (Burgess.).....	8vo,	4 00
Eissler's Modern High Explosives.....	8vo,	4 00
Effront's Enzymes and their Applications. (Prescott.).....	8vo,	3 00

<b>Erdmann's Introduction to Chemical Preparations.</b> (Dunlap.).....	12mo,	1	25
<b>Fletcher's Practical Instructions in Quantitative Assaying with the Blowpipe</b>	12mo, morocco,	1	50
<b>Fowler's Sewage Works Analyses</b> .....	12mo,	2	00
<b>Fresenius's Manual of Qualitative Chemical Analysis.</b> (Wells.).....	8vo,	5	00
<b>Manual of Qualitative Chemical Analysis. Part I. Descriptive.</b> (Wells.)	8vo,	3	00
<b>System of Instruction in Quantitative Chemical Analysis.</b> (Cohn.)	2 vols.....	8vo,	12 50
<b>Fuertes's Water and Public Health</b> .....	12mo,	1	50
<b>Furman's Manual of Practical Assaying</b> .....	8vo,	3	00
<b>Getman's Exercises in Physical Chemistry</b> .....	12mo,		
<b>Gill's Gas and Fuel Analysis for Engineers</b> .....	12mo,	1	25
<b>Grotenfelt's Principles of Modern Dairy Practice.</b> (Woll.).....	12mo,	2	00
<b>Hammarsten's Text-book of Physiological Chemistry.</b> (Mandel.).....	8vo,	4	00
<b>Helm's Principles of Mathematical Chemistry.</b> (Morgan.).....	12mo,	1	50
<b>Hering's Ready Reference Tables (Conversion Factors)</b> .....	16mo, morocco,	2	50
<b>Hinds's Inorganic Chemistry</b> .....	8vo,	3	00
* <b>Laboratory Manual for Students</b> .....	12mo,		75
<b>Holleman's Text-book of Inorganic Chemistry.</b> (Cooper.).....	8vo,	2	50
<b>Text-book of Organic Chemistry.</b> (Walker and Mott.).....	8vo,	2	50
* <b>Laboratory Manual of Organic Chemistry.</b> (Walker.).....	12mo,	1	00
<b>Hopkins's Oil-chemists' Handbook</b> .....	8vo,	3	00
<b>Jackson's Directions for Laboratory Work in Physiological Chemistry</b> .....	8vo,	1	25
<b>Keep's Cast Iron</b> .....	8vo,	2	50
<b>Ladd's Manual of Quantitative Chemical Analysis</b> .....	12mo,	1	00
<b>Landauer's Spectrum Analysis.</b> (Tingle.).....	8vo,	3	00
<b>Lassar-Cohn's Practical Urinary Analysis.</b> (Lorenz.).....	12mo,	1	00
<b>Application of Some General Reactions to Investigations in Organic Chemistry.</b> (Tingle.).....	12mo,	1	00
<b>Leach's The Inspection and Analysis of Food with Special Reference to State Control</b> .....	8vo,	7	50
<b>Lüb's Electrolysis and Electrosynthesis of Organic Compounds.</b> (Lorenz.)	12mo,	1	00
<b>Lodge's Notes on Assaying and Metallurgical Laboratory Experiments</b> ....	8vo,	3	00
<b>Lunge's Techno-chemical Analysis.</b> (Cohn.).....	12mo,	1	00
<b>Mandel's Handbook for Bio-chemical Laboratory</b> .....	12mo,	1	50
* <b>Martin's Laboratory Guide to Qualitative Analysis with the Blowpipe</b> .....	12mo,		60
<b>Mason's Water-supply.</b> (Considered Principally from a Sanitary Standpoint.)	3d Edition, Rewritten.....	8vo,	4 00
<b>Examination of Water.</b> (Chemical and Bacteriological.).....	12mo,	1	25
<b>Matthews's The Textile Fibres</b> .....	8vo,	3	50
<b>Meyer's Determination of Radicles in Carbon Compounds.</b> (Tingle.).....	12mo,	1	00
<b>Miller's Manual of Assaying</b> .....	12mo,	1	00
<b>Mixter's Elementary Text-book of Chemistry</b> .....	12mo,	1	50
<b>Morgan's Outline of Theory of Solution and its Results</b> .....	12mo,	1	00
<b>Elements of Physical Chemistry</b> .....	12mo,	2	00
<b>Morse's Calculations used in Cane-sugar Factories</b> .....	16mo, morocco,	1	50
<b>Mulliken's General Method for the Identification of Pure Organic Compounds.</b>	Vol. I. ....	Large 8vo,	5 00
<b>O'Brine's Laboratory Guide in Chemical Analysis</b> .....	8vo,	2	00
<b>O'Driscoll's Notes on the Treatment of Gold Ores</b> .....	8vo,	2	00
<b>Ostwald's Conversations on Chemistry. Part One.</b> (Ramsey.) ( <i>In press.</i> )			
* <b>Penfield's Notes on Determinative Mineralogy and Record of Mineral Tests.</b>	8vo, paper,		50
<b>Pictet's The Alkaloids and their Chemical Constitution.</b> (Biddle.).....	8vo,	5	00
<b>Pinner's Introduction to Organic Chemistry.</b> (Austen.).....	12mo,	1	50
<b>Poole's Calorific Power of Fuels</b> .....	8vo,	3	00
<b>Prescott and Winslow's Elements of Water Bacteriology, with Special Reference to Sanitary Water Analysis</b> .....	12mo,	1	25

* Reisig's Guide to Piece-dyeing.....	8vo, 25	00
Richards and Woodman's Air, Water, and Food from a Sanitary Standpoint.....	8vo, 2	00
Richards's Cost of Living as Modified by Sanitary Science.....	12mo 1	00
Cost of Food a Study in Dietsaries.....	12mo, 1	00
* Richards and Williams's The Dietary Computer.....	8vo, 1	50
Ricketts and Russell's Skeleton Notes upon Inorganic Chemistry. (Part I.—Non-metallic Elements.).....	8vo, morocco,	75
Ricketts and Miller's Notes on Assaying.....	8vo, 3	00
Rideal's Sewage and the Bacterial Purification of Sewage.....	8vo, 3	50
Disinfection and the Preservation of Food.....	8vo, 4	00
Riggs's Elementary Manual for the Chemical Laboratory.....	8vo, 1	25
Rostoski's Serum Diagnosis. (Bolduan.).....	12mo, 1	00
Ruddiman's Incompatibilities in Prescriptions.....	8vo, 2	00
Sabin's Industrial and Artistic Technology of Paints and Varnish.....	8vo, 3	00
Salkowski's Physiological and Pathological Chemistry. (Orndorff.).....	8vo, 2	50
Schimpf's Text-book of Volumetric Analysis.....	12mo, 2	50
Essentials of Volumetric Analysis.....	12mo, 1.	25
Spencer's Handbook for Chemists of Beet-sugar Houses.....	16mo, morocco, 3	00
Handbook for Sugar Manufacturers and their Chemists.....	16mo, morocco, 2	00
Stockbridge's Rocks and Soils.....	8vo, 2	50
* Tillman's Elementary Lessons in Heat.....	8vo, 1	50
* Descriptive General Chemistry.....	8vo, 3	00
Treadwell's Qualitative Analysis. (Hall.).....	8vo, 3	00
Quantitative Analysis. (Hall.).....	8vo, 4	00
Turneure and Russell's Public Water-supplies.....	8vo, 5	00
Van Deventer's Physical Chemistry for Beginners. (Boltwood.).....	12mo, 1	50
* Walke's Lectures on Explosives.....	8vo, 4	00
Washington's Manual of the Chemical Analysis of Rocks.....	8vo, 2	00
Wassermann's Immune Sera: Hæmolysins, Cytotoxins, and Precipitins. (Bolduan.).....	12mo, 1	00
Wells's Laboratory Guide in Qualitative Chemical Analysis.....	8vo, 1	50
Short Course in Inorganic Qualitative Chemical Analysis for Engineering Students.....	12mo, 1	50
Whipple's Microscopy of Drinking-water.....	8vo, 3	50
Wiechmann's Sugar Analysis.....	Small 8vo, 2	50
Wilson's Cyanide Processes.....	12mo, 1	50
Chlorination Process.....	12mo, 1	50
Wulling's Elementary Course in Inorganic Pharmaceutical and Medical Chemistry.....	12mo, 2	00

## CIVIL ENGINEERING.

### BRIDGES AND ROOFS. HYDRAULICS. MATERIALS OF ENGINEERING RAILWAY ENGINEERING.

Baker's Engineers' Surveying Instruments.....	12mo, 3	00
Birby's Graphical Computing Table.....	Paper 19½ X 24½ inches. 25	
** Burr's Ancient and Modern Engineering and the Isthmian Canal. (Postage, 27 cents additional.).....	8vo, net, 3	50
Comstock's Field Astronomy for Engineers.....	8vo, 2	50
Davis's Elevation and Stadia Tables.....	8vo, 1	00
Elliott's Engineering for Land Drainage.....	12mo, 1	50
Practical Farm Drainage.....	12mo, 1	00
Folwell's Sewerage. (Designing and Maintenance.).....	8vo, 3	00
Freitag's Architectural Engineering. 2d Edition Rewritten.....	8vo, 3	50
French and Ives's Stereotomy.....	8vo, 2	50
Goodhue's Municipal Improvements.....	12mo, 1	75
Goodrich's Economic Disposal of Towns' Refuse.....	8vo, 3	50
Gore's Elements of Geodesy.....	8vo, 2	50
Hayford's Text-book of Geodetic Astronomy.....	8vo, 3	00
Hering's Ready Reference Tables (Conversion Factors).....	16mo, morocco, 2	50

Howe's Retaining Walls for Earth.....	12mo,	1 25
Johnson's (J. B.) Theory and Practice of Surveying.....	Small 8vo,	4 00
Johnson's (L. J.) Statics by Algebraic and Graphic Methods.....	8vo,	2 00
Laplace's Philosophical Essay on Probabilities. (Truscott and Emory.)	12mo,	2 00
Mahan's Treatise on Civil Engineering. (1873.) (Wood.)	8vo,	5 00
* Descriptive Geometry.....	8vo,	1 50
Merriman's Elements of Precise Surveying and Geodesy.....	8vo,	2 50
Elements of Sanitary Engineering.....	8vo,	2 00
Merriman and Brooks's Handbook for Surveyors.....	16mo, morocco,	2 00
Nugent's Plane Surveying.....	8vo	3 50
Ogden's Sewer Design.....	12mo,	2 00
Patton's Treatise on Civil Engineering.....	8vo half leather,	7 50
Reed's Topographical Drawing and Sketching.....	4to,	5 00
Rideal's Sewage and the Bacterial Purification of Sewage.....	8vo,	3 50
Siebert and Biggin's Modern Stone-cutting and Masonry.....	8vo,	1 50
Smith's Manual of Topographical Drawing. (McMillan.)	8vo,	2 50
Sondericker's Graphic Statics, with Applications to Trusses, Beams, and Arches.....	8vo,	2 00
Taylor and Thompson's Treatise on Concrete, Plain and Reinforced. ( <i>In press.</i> )		
* Trautwine's Civil Engineer's Pocket-book.....	16mo, morocco,	5 00
Wait's Engineering and Architectural Jurisprudence.....	8vo,	6 00
	Sheep,	6 50
Law of Operations Preliminary to Construction in Engineering and Archi- tecture.....	8vo,	5 00
	Sheep,	5 50
Law of Contracts.....	8vo,	3 00
Warren's Stereotomy—Problems in Stone-cutting.....	8vo,	2 50
Webb's Problems in the Use and Adjustment of Engineering Instruments.	16mo, morocco,	1 25
* Wheeler's Elementary Course of Civil Engineering.....	8vo,	4 00
Wilson's Topographic Surveying.....	8vo,	3 50

## BRIDGES AND ROOFS.

Boller's Practical Treatise on the Construction of Iron Highway Bridges..	8vo,	2 00
* Thames River Bridge.....	4to, paper,	5 00
Burr's Course on the Stresses in Bridges and Roof Trusses, Arched Ribs, and Suspension Bridges.....	8vo,	3 50
Du Bois's Mechanics of Engineering. Vol. II.....	Small 4to,	10 00
Poster's Treatise on Wooden Trestle Bridges.....	4to,	5 00
Fowler's Cofferdam Process for Piers.....	8vo,	2 50
Ordinary Foundations.....	8vo,	3 50
Greene's Roof Trusses.....	8vo,	1 25
Bridge Trusses.....	8vo,	2 50
Arches in Wood, Iron, and Stone.....	8vo,	2 50
Howe's Treatise on Arches.....	8vo,	4 00
Design of Simple Roof-trusses in Wood and Steel.....	8vo,	2 00
Johnson, Bryan, and Turneure's Theory and Practice in the Designing of Modern Framed Structures.....	Small 4to,	10 00
Merriman and Jacoby's Text-book on Roofs and Bridges:		
Part I.—Stresses in Simple Trusses.....	8vo,	2 50
Part II.—Graphic Statics.....	8vo,	2 50
Part III.—Bridge Design. 4th Edition, Rewritten.....	8vo,	2 50
Part IV.—Higher Structures.....	8vo,	2 50
Morison's Memphis Bridge.....	4to,	10 00
Waddell's De Pontibus, a Pocket-book for Bridge Engineers..	16mo, morocco,	3 00
Specifications for Steel Bridges.....	12mo,	1 25
Wood's Treatise on the Theory of the Construction of Bridges and Roofs.	8vo,	2 00
Wright's Designing of Draw-spans:		
Part I. —Plate-girder Draws.....	8vo,	2 50
Part II.—Riveted-truss and Pin-connected Long-span Draws.....	8vo,	2 50
Two parts in one volume.....	8vo,	3 50

## HYDRAULICS.

Bazin's Experiments upon the Contraction of the Liquid Vein Issuing from an Orifice. (Trautwine.)	8vo,	2 00
Bovey's Treatise on Hydraulics.	8vo,	5 00
Church's Mechanics of Engineering.	8vo,	6 00
Diagrams of Mean Velocity of Water in Open Channels	paper,	1 50
Coffin's Graphical Solution of Hydraulic Problems.	16mo, morocco,	2 50
Fletcher's Dynamometers, and the Measurement of Power.	12mo,	3 00
Folwell's Water-supply Engineering.	8vo,	4 00
Frizell's Water-power.	8vo,	5 00
Fuertes's Water and Public Health.	12mo,	1 50
Water-filtration Works.	12mo,	2 50
Ganguillet and Kutter's General Formula for the Uniform Flow of Water in Rivers and Other Channels. (Hering and Trautwine.)	8vo,	4 00
Hazen's Filtration of Public Water-supply.	8vo,	3 00
Hazlehurst's Towers and Tanks for Water-works.	8vo,	2 50
Herschel's 115 Experiments on the Carrying Capacity of Large, Riveted, Metal Conduits.	8vo,	2 00
Mason's Water-supply. (Considered Principally from a Sanitary Stand-point.) 3d Edition, Rewritten	8vo,	4 00
Merriman's Treatise on Hydraulics. 9th Edition, Rewritten.	8vo,	5 00
* Michie's Elements of Analytical Mechanics.	8vo,	4 00
Schuyler's Reservoirs for Irrigation, Water-power, and Domestic Water-supply.	Large 8vo,	5 00
** Thomas and Watt's Improvement of Rivers. (Post., 44 c. additional),	4to,	6 00
Turneure and Russell's Public Water-supplies.	8vo,	5 00
Wegmann's Design and Construction of Dams.	4to,	5 00
Water-supply of the City of New York from 1658 to 1895.	4to,	10 00
Weisbach's Hydraulics and Hydraulic Motors. (Du Bois.)	8vo,	5 00
Wilson's Manual of Irrigation Engineering.	Small 8vo,	4 00
Wolf's Windmill as a Prime Mover.	8vo,	3 00
Wood's Turbines.	8vo,	2 50
Elements of Analytical Mechanics.	8vo,	3 00

## MATERIALS OF ENGINEERING.

Baker's Treatise on Masonry Construction.	8vo,	5 00
Roads and Pavements.	8vo,	5 00
Black's United States Public Works.	Oblong 4to,	5 00
Bovey's Strength of Materials and Theory of Structures.	8vo,	7 50
Burr's Elasticity and Resistance of the Materials of Engineering. 6th Edition, Rewritten.	8vo,	7 50
Byrne's Highway Construction.	8vo,	5 00
Inspection of the Materials and Workmanship Employed in Construction.	16mo,	3 00
Church's Mechanics of Engineering.	8vo,	6 00
Du Bois's Mechanics of Engineering. Vol. I.	Small 4to,	7 50
Johnson's Materials of Construction.	Large 8vo,	6 00
Fowler's Ordinary Foundations.	8vo,	3 50
Keep's Cast Iron.	8vo,	2 50
Lanza's Applied Mechanics.	8vo,	7 50
Martens's Handbook on Testing Materials. (Henning.) 2 vols.	8vo,	7 50
Merrill's Stones for Building and Decoration.	8vo,	5 00
Merriman's Text-book on the Mechanics of Materials.	8vo,	4 00
Strength of Materials.	12mo,	1 00
Metcalf's Steel. A Manual for Steel-users.	12mo,	2 00
Patton's Practical Treatise on Foundations.	8vo,	5 00
Richey's Handbook for Building Superintendents of Construction. (In press.)		
Rockwell's Roads and Pavements in France.	12mo,	1 25

Sabin's Industrial and Artistic Technology of Paints and Varnish.....	8vo,	3 00
Smith's Materials of Machines.....	12mo,	1 00
Snow's Principal Species of Wood.....	8vo,	3 50
Spalding's Hydraulic Cement.....	12mo,	2 00
Text-book on Roads and Pavements.....	12mo,	2 00
Taylor and Thompson's Treatise on Concrete, Plain and Reinforced. ( <i>In press.</i> )		
Thurston's Materials of Engineering. 3 Parts.....	8vo,	8 00
Part I.—Non-metallic Materials of Engineering and Metallurgy.....	8vo,	2 00
Part II.—Iron and Steel.....	8vo,	3 50
Part III.—A Treatise on Brasses, Bronzes, and Other Alloys and their Constituents.....	8vo,	2 50
Thurston's Text-book of the Materials of Construction.....	8vo,	5 00
Tillson's Street Pavements and Paving Materials.....	8vo,	4 00
Waddell's De Pontibus. (A Pocket-book for Bridge Engineers.).....	16mo, mor.,	3 00
Specifications for Steel Bridges.....	12mo,	1 25
Wood's (De V.) Treatise on the Resistance of Materials, and an Appendix on the Preservation of Timber.....	8vo,	2 00
Wood's (De V.) Elements of Analytical Mechanics.....	8vo,	3 00
Wood's (M. P.) Rustless Coatings: Corrosion and Electrolysis of Iron and Steel.....	8vo,	4 00

### RAILWAY ENGINEERING.

Andrews's Handbook for Street Railway Engineers.....	3x5 inches, morocco,	1 25
Berg's Buildings and Structures of American Railroads.....	4to,	5 00
Brooks's Handbook of Street Railroad Location.....	16mo, morocco,	1 50
Butts's Civil Engineer's Field-book.....	16mo, morocco,	2 50
Crandall's Transition Curve.....	16mo, morocco,	1 50
Railway and Other Earthwork Tables.....	8vo,	1 50
Dawson's "Engineering" and Electric Traction Pocket-book.....	16mo, morocco,	5 00
Dredge's History of the Pennsylvania Railroad: (1879).....	Paper,	5 00
* Drinker's Tunneling, Explosive Compounds, and Rock Drills.....	4to, half mor.,	25 00
Fisher's Table of Cubic Yards.....	Cardboard,	25
Godwin's Railroad Engineers' Field-book and Explorers' Guide.....	16mo, mor.,	2 50
Howard's Transition Curve Field-book.....	16mo, morocco,	1 50
Hudson's Tables for Calculating the Cubic Contents of Excavations and Embankments.....	8vo,	1 00
Molitor and Beard's Manual for Resident Engineers.....	16mo,	1 00
Nagle's Field Manual for Railroad Engineers.....	16mo, morocco,	3 00
Philbrick's Field Manual for Engineers.....	16mo, morocco,	3 00
Searles's Field Engineering.....	16mo, morocco,	3 00
Railroad Spiral.....	16mo, morocco,	1 50
Taylor's Prismatical Formulæ and Earthwork.....	8vo,	1 50
* Trautwine's Method of Calculating the Cubic Contents of Excavations and Embankments by the Aid of Diagrams.....	8vo,	2 00
The Field Practice of Laying Out Circular Curves for Railroads.....	12mo, morocco,	2 50
Cross-section Sheet.....	Paper,	25
Webb's Railroad Construction. 2d Edition, Rewritten.....	16mo, morocco,	5 00
Wellington's Economic Theory of the Location of Railways.....	Small 8vo,	5 00

### DRAWING.

Barr's Kinematics of Machinery.....	8vo,	2 50
* Bartlett's Mechanical Drawing.....	8vo,	3 00
* " Abridged Ed.....	8vo,	1 50
Coolidge's Manual of Drawing.....	8vo, paper,	1 00
Coolidge and Freeman's Elements of General Drafting for Mechanical Engineers.....	Oblong 4to,	2 50
Durley's Kinematics of Machines.....	8vo,	4 00

Hill's Text-book on Shades and Shadows, and Perspective. ....	8vo.	2 00
Jamison's Elements of Mechanical Drawing. ....	8vo,	2 50
Jones's Machine Design:		
Part I.—Kinematics of Machinery. ....	8vo,	1 50
Part II.—Form, Strength, and Proportions of Parts. ....	8vo,	3 00
MacCord's Elements of Descriptive Geometry. ....	8vo,	3 00
Kinematics; or, Practical Mechanism. ....	8vo,	5 00
Mechanical Drawing. ....	4to,	4 00
Velocity Diagrams. ....	8vo,	1 50
Mahan's Descriptive Geometry and Stone-cutting. ....	8vo,	1 50
Industrial Drawing. (Thompson.). ....	8vo,	3 50
Moyer's Descriptive Geometry. ( <i>In press.</i> )		
Reed's Topographical Drawing and Sketching. ....	4to,	5 00
Reid's Course in Mechanical Drawing. ....	8vo,	2 00
Text-book of Mechanical Drawing and Elementary Machine Design. ....	8vo,	3 00
Robinson's Principles of Mechanism. ....	8vo,	3 00
Schwamb and Merrill's Elements of Mechanism. ....	8vo,	3 00
Smith's Manual of Topographical Drawing. (McMillan.). ....	8vo,	2 50
Warren's Elements of Plane and Solid Free-hand Geometrical Drawing. ....	12mo,	1 00
Drafting Instruments and Operations. ....	12mo,	1 25
Manual of Elementary Projection Drawing. ....	12mo,	1 50
Manual of Elementary Problems in the Linear Perspective of Form and Shadow. ....	12mo,	1 00
Plane Problems in Elementary Geometry. ....	12mo,	1 25
Primary Geometry. ....	12mo,	75
Elements of Descriptive Geometry, Shades, and Perspective. ....	8vo,	3 50
General Problems of Shades and Shadows. ....	8vo,	3 00
Elements of Machine Construction and Drawing. ....	8vo,	7 50
Problems, Theorems, and Examples in Descriptive Geometry. ....	8vo,	2 50
Weisbach's Kinematics and the Power of Transmission. (Hermann and Klein.). ....	8vo,	5 00
Whelpley's Practical Instruction in the Art of Letter Engraving. ....	12mo,	2 00
Wilson's (H. M.) Topographic Surveying. ....	8vo,	3 50
Wilson's (V. T.) Free-hand Perspective. ....	8vo,	2 50
Wilson's (V. T.) Free-hand Lettering. ....	8vo,	1 00
Woolf's Elementary Course in Descriptive Geometry. ....	Large 8vo,	3 00

## ELECTRICITY AND PHYSICS.

Anthony and Brackett's Text-book of Physics. (Magie.). ....	Small 8vo,	3 00
Anthony's Lecture-notes on the Theory of Electrical Measurements. ....	12mo,	1 00
Benjamin's History of Electricity. ....	8vo,	3 00
Voltaic Cell. ....	8vo,	3 00
Classen's Quantitative Chemical Analysis by Electrolysis. (Boltwood.). ....	8vo,	3 00
Crehore and Squier's Polarizing Photo-chronograph. ....	8vo,	3 00
Dawson's "Engineering" and Electric Traction Pocket-book. ....	16mo, morocco,	5 00
Dolezalek's Theory of the Lead Accumulator (Storage Battery). (Von Ende.). ....	12mo,	2 50
Duhem's Thermodynamics and Chemistry. (Burgess.). ....	8vo,	4 00
Flather's Dynamometers, and the Measurement of Power. ....	12mo,	3 00
Gilbert's De Magnete. (Mottelay.). ....	8vo,	2 50
Hanchett's Alternating Currents Explained. ....	12mo,	1 00
Hering's Ready Reference Tables (Conversion Factors). ....	16mo, morocco,	2 50
Holman's Precision of Measurements. ....	8vo,	2 00
Telescopic Mirror-scale Method, Adjustments, and Tests. ....	Large 8vo,	75
Landauer's Spectrum Analysis. (Tingle.). ....	8vo,	3 00
Le Chatelier's High-temperature Measurements. (Boudouard—Burgess.). ....	12mo	3 00
Löb's Electrolysis and Electrosynthesis of Organic Compounds. (Lorenz.). ....	12mo,	1 00

* Lyons's Treatise on Electromagnetic Phenomena. Vols. I. and II. 8vo, each,	6 00
* Michie. Elements of Wave Motion Relating to Sound and Light.....8vo,	4 00
Niaudet's Elementary Treatise on Electric Batteries. (Fishback.).....12mo,	2 50
* Rosenberg's Electrical Engineering. (Haldane Gee—Kinzbrunner.)....8vo,	1 50
Ryan, Norris, and Hoxie's Electrical Machinery. Vol. L.....8vo,	2 50
Thurston's Stationary Steam-engines.....8vo,	2 50
* Tillman's Elementary Lessons in Heat.....8vo,	1 50
Tory and Pitcher's Manual of Laboratory Physics.....Small 8vo,	2 00
Ulke's Modern Electrolytic Copper Refining.....8vo,	3 00

## LAW.

* Davis's Elements of Law.....8vo,	2 50
* Treatise on the Military Law of United States.....8vo,	7 00
* Sheep,	7 50
Manual for Courts-martial.....16mo, morocco,	1 50
Wait's Engineering and Architectural Jurisprudence.....8vo,	6 00
Sheep,	6 50
Law of Operations Preliminary to Construction in Engineering and Archi- tecture.....8vo,	5 00
Sheep,	5 50
Law of Contracts.....8vo,	3 00
Winthrop's Abridgment of Military Law.....12mo,	2 50

## MANUFACTURES.

Bernadou's Smokeless Powder—Nitro-cellulose and Theory of the Cellulose Molecule.....12mo,	2 50
Bolland's Iron Founder.....12mo,	2 50
"The Iron Founder," Supplement.....12mo,	2 50
Encyclopedia of Founding and Dictionary of Foundry Terms Used in the Practice of Moulding.....12mo,	3 00
Eissler's Modern High Explosives.....8vo,	4 00
Effront's Enzymes and their Applications. (Prescott.).....8vo	3 00
Fitzgerald's Boston Machinist.....18mo,	1 00
Ford's Boiler Making for Boiler Makers.....18mo,	1 00
Hopkins's Oil-chemists' Handbook.....8vo,	3 00
Keep's Cast Iron.....8vo,	2 50
Leach's The Inspection and Analysis of Food with Special Reference to State Control. ( <i>In preparation.</i> )	
Matthews's The Textile Fibres.....8vo,	3 50
Metcalf's Steel. A Manual for Steel-users.....12mo,	2 00
Metcalf's Cost of Manufactures—And the Administration of Workshops, Public and Private.....8vo,	5 00
Meyer's Modern Locomotive Construction.....4to,	10 00
Morse's Calculations used in Cane-sugar Factories.....16mo, morocco,	1 50
* Reisig's Guide to Piece-dyeing.....8vo,	25 00
Sabin's Industrial and Artistic Technology of Paints and Varnish.....8vo,	3 00
Smith's Press-working of Metals.....8vo,	3 00
Spalding's Hydraulic Cement.....12mo,	2 00
Spencer's Handbook for Chemists of Beet-sugar Houses....16mo, morocco,	3 00
Handbook for Sugar Manufacturers and their Chemists..16mo morocco,	2 00
Taylor and Thompson's Treatise on Concrete, Plain and Reinforced. ( <i>In press.</i> )	
Thurston's Manual of Steam-boilers, their Designs, Construction and Opera- tion.....8vo,	5 00
* Walke's Lectures on Explosives.....8vo,	4 00
West's American Foundry Practice.....12mo,	2 50
Moulder's Text-book.....12mo,	2 50





Cromwell's Treatise on Toothed Gearing.....	12mo	1 50
Treatise on Belts and Pulleys.....	12mo,	1 50
Durley's Kinematics of Machines.....	8vo,	4 00
Flather's Dynamometers and the Measurement of Power.....	12mo,	3 00
Rope Driving.....	12mo,	2 00
Gill's Gas and Fuel Analysis for Engineers.....	12mo,	1 25
Hall's Car Lubrication.....	12mo,	1 00
Hering's Ready Reference Tables (Conversion Factors).....	16mo, morocco,	2 50
Hutton's The Gas Engine.....	8vo,	5 00
Jamison's Mechanical Drawing.....	8vo,	2 50
Jones's Machine Design:		
Part I.—Kinematics of Machinery.....	8vo,	1 50
Part II.—Form, Strength, and Proportions of Parts.....	8vo,	3 00
Kent's Mechanical Engineer's Pocket-book.....	16mo, morocco,	5 00
Kerr's Power and Power Transmission.....	8vo,	2 00
Leonard's Machine Shops, Tools, and Methods. ( <i>In press</i> .)		
MacCord's Kinematics; or, Practical Mechanism.....	8vo,	5 00
Mechanical Drawing.....	4to,	4 00
Velocity Diagrams.....	8vo,	1 50
Mahan's Industrial Drawing. (Thompson.).....	8vo,	3 50
Poole's Calorific Power of Fuels.....	8vo,	3 00
Reid's Course in Mechanical Drawing.....	8vo,	2 00
Text-book of Mechanical Drawing and Elementary Machine Design.....	8vo,	3 00
Richards's Compressed Air.....	12mo,	1 50
Robinson's Principles of Mechanism.....	8vo,	3 00
Schwamb and Merrill's Elements of Mechanism.....	8vo,	3 00
Smith's Press-working of Metals.....	8vo,	3 00
Thurston's Treatise on Friction and Lost Work in Machinery and Mill Work.....	8vo,	3 00
Animal as a Machine and Prime Motor, and the Laws of Energetics.....	12mo,	1 00
Warren's Elements of Machine Construction and Drawing.....	8vo,	7 50
Weisbach's Kinematics and the Power of Transmission. Herrmann—Klein.).....	8vo,	5 00
Machinery of Transmission and Governors. (Herrmann—Klein.).....	8vo,	5 00
Hydraulics and Hydraulic Motors. (Du Bois.).....	8vo,	5 00
Wolff's Windmill as a Prime Mover.....	8vo,	3 00
Wood's Turbines.....	8vo,	2 50

## MATERIALS OF ENGINEERING.

Bovey's Strength of Materials and Theory of Structures.....	8vo,	7 50
Burr's Elasticity and Resistance of the Materials of Engineering. 6th Edition Reset.....	8vo,	7 50
Church's Mechanics of Engineering.....	8vo,	6 00
Johnson's Materials of Construction.....	Large 8vo,	6 00
Keep's Cast Iron.....	8vo,	2 50
Lanza's Applied Mechanics.....	8vo,	7 50
Martens's Handbook on Testing Materials. (Henning.).....	8vo,	7 50
Merriman's Text-book on the Mechanics of Materials.....	8vo,	4 00
Strength of Materials.....	12mo,	1 00
Metcalf's Steel. A Manual for Steel-users.....	12mo	2 00
Sabin's Industrial and Artistic Technology of Paints and Varnish.....	8vo,	3 00
Smith's Materials of Machines.....	12mo,	1 00
Thurston's Materials of Engineering.....	3 vols, 8vo,	8 00
Part II.—Iron and Steel.....	8vo,	3 50
Part III.—A Treatise on Brasses, Bronzes, and Other Alloys and their Constituents.....	8vo	2 50
Text-book of the Materials of Construction.....	8vo,	5 00

Wood's (De V.) Treatise on the Resistance of Materials and an Appendix on the Preservation of Timber.....	8vo,	2 00
Wood's (De V.) Elements of Analytical Mechanics.....	8vo,	3 00
Wood's (M. P.) Rustless Coatings: Corrosion and Electrolysis of Iron and Steel.....	8vo,	4 00

## STEAM-ENGINES AND BOILERS.

Carnot's Reflections on the Motive Power of Heat. (Thurston.).....	12mo,	1 50
Dawson's "Engineering" and Electric Traction Pocket-book.....	16mo, mcr.,	5 00
Ford's Boiler Making for Boiler Makers.....	18mo,	1 00
Goss's Locomotive Sparks.....	8vo,	2 00
Hemenway's Indicator Practice and Steam-engine Economy.....	12mo,	2 00
Hutton's Mechanical Engineering of Power Plants.....	8vo,	5 00
Heat and Heat-engines.....	8vo,	5 00
Kent's Steam-boiler Economy.....	8vo,	4 00
Kneass's Practice and Theory of the Injector.....	8vo,	1 50
MacCord's Slide-valves.....	8vo,	2 00
Meyer's Modern Locomotive Construction.....	4to,	10 00
Peabody's Manual of the Steam-engine Indicator.....	12mo,	1 50
Tables of the Properties of Saturated Steam and Other Vapors.....	8vo,	1 00
Thermodynamics of the Steam-engine and Other Heat-engines.....	8vo,	5 00
Valve-gears for Steam-engines.....	8vo,	2 50
Peabody and Miller's Steam-boilers.....	8vo,	4 00
Pray's Twenty Years with the Indicator.....	Large 8vo,	2 50
Puplin's Thermodynamics of Reversible Cycles in Gases and Saturated Vapors. (Osterberg.).....	12mo,	1 25
Reagan's Locomotives: Simple, Compound, and Electric.....	12mo,	2 50
Rontgen's Principles of Thermodynamics. (Du Bois.).....	8vo,	5 00
Sinclair's Locomotive Engine Running and Management.....	12mo,	2 00
Smart's Handbook of Engineering Laboratory Practice.....	12mo,	2 50
Snow's Steam-boiler Practice.....	8vo,	3 00
Spangler's Valve-gears.....	8vo,	2 50
Notes on Thermodynamics.....	12mo,	1 00
Spangler, Greene, and Marshall's Elements of Steam-engineering.....	8vo,	3 00
Thurston's Handy Tables.....	8vo,	1 50
Manual of the Steam-engine.....	2 vols. 8vo,	10 00
Part I.—History, Structure, and Theory.....	8vo,	6 00
Part II.—Design, Construction, and Operation.....	8vo,	6 00
Handbook of Engine and Boiler Trials, and the Use of the Indicator and the Prony Brake.....	8vo,	5 00
Stationary Steam-engines.....	8vo,	2 50
Steam-boiler Explosions in Theory and in Practice.....	12mo,	1 50
Manual of Steam-boilers, Their Designs, Construction, and Operation.....	8vo,	5 00
Weisbach's Heat, Steam, and Steam-engines. (Du Bois.).....	8vo,	5 00
Whitham's Steam-engine Design.....	8vo,	5 00
Wilson's Treatise on Steam-boilers. (Flather.).....	16mo,	2 50
Wood's Thermodynamics Heat Motors, and Refrigerating Machines....	8vo,	4 00

## MECHANICS AND MACHINERY.

Barr's Kinematics of Machinery.....	8vo,	2 50
Bovey's Strength of Materials and Theory of Structures.....	8vo,	7 50
Chase's The Art of Pattern-making.....	12mo,	2 50
Chordal.—Extracts from Letters.....	12mo,	2 00
Church's Mechanics of Engineering.....	8vo,	6 00

Church's Notes and Examples in Mechanics.....	8vo,	2 00
Compton's First Lessons in Metal-working.....	12mo,	1 50
Compton and De Groodt's The Speed Lathe.....	12mo,	1 50
Cromwell's Treatise on Toothed Gearing.....	12mo,	1 50
Treatise on Belts and Pulleys.....	12mo,	1 50
Dana's Text-book of Elementary Mechanics for the Use of Colleges and Schools.....	12mo,	1 50
Dingey's Machinery Pattern Making.....	12mo,	2 00
Dredge's Record of the Transportation Exhibits Building of the World's Columbian Exposition of 1893.....	4to half morocco,	5 00
Du Bois's Elementary Principles of Mechanics:		
Vol. I.—Kinematics.....	8vo	3 50
Vol. II.—Statics.....	8vo,	4 00
Vol. III.—Kinetics.....	8vo,	3 50
Mechanics of Engineering. Vol. I.....	Small 4to,	7 50
Vol. II.....	Small 4to,	10 00
Durley's Kinematics of Machines.....	8vo,	4 00
Fitzgerald's Boston Machinist.....	16mo,	1 00
Flather's Dynamometers, and the Measurement of Power.....	12mo,	3 00
Rope Driving.....	12mo,	2 00
Goss's Locomotive Sparks.....	8vo,	2 00
Hall's Car Lubrication.....	12mo,	1 00
Holly's Art of Saw Filing.....	18mo,	75
* Johnson's (W. W.) Theoretical Mechanics.....	12mo,	3 00
Johnson's (L. J.) Statics by Graphic and Algebraic Methods.....	8vo,	2 00
Jones's Machine Design:		
Part I.—Kinematics of Machinery.....	8vo,	1 50
Part II.—Form, Strength, and Proportions of Parts.....	8vo,	3 00
Kerr's Power and Power Transmission.....	8vo,	2 00
Lanza's Applied Mechanics.....	8vo,	7 50
Leonard's Machine Shops, Tools, and Methods. ( <i>In press.</i> )		
MacCord's Kinematics; or, Practical Mechanism.....	8vo,	5 00
Velocity Diagrams.....	8vo,	1 50
Maurer's Technical Mechanics.....	8vo,	4 00
Merriman's Text-book on the Mechanics of Materials.....	8vo,	4 00
* Michie's Elements of Analytical Mechanics.....	8vo,	4 00
Reagan's Locomotives: Simple, Compound, and Electric.....	12mo,	2 50
Reid's Course in Mechanical Drawing.....	8vo,	2 00
Text-book of Mechanical Drawing and Elementary Machine Design.....	8vo,	3 00
Richards's Compressed Air.....	12mo,	1 50
Robinson's Principles of Mechanism.....	8vo,	3 00
Ryan, Norris, and Hoxie's Electrical Machinery. Vol. I.....	8vo,	2 50
Schwamb and Merrill's Elements of Mechanism.....	8vo,	3 00
Sinclair's Locomotive-engine Running and Management.....	12mo,	2 00
Smith's Press-working of Metals.....	8vo,	3 00
Materials of Machines.....	12mo,	1 00
Spangler, Greene, and Marshall's Elements of Steam-engineering.....	8vo,	3 00
Thurston's Treatise on Friction and Lost Work in Machinery and Mill Work.....	8vo,	3 00
Animal as a Machine and Prime Motor, and the Laws of Energetics.....	12mo,	1 00
Warren's Elements of Machine Construction and Drawing.....	8vo,	7 50
Weisbach's Kinematics and the Power of Transmission. (Herrmann— Klein.).....	8vo,	5 00
Machinery of Transmission and Governors. (Herrmann—Klein.).....	8vo,	5 00
Wood's Elements of Analytical Mechanics.....	8vo,	3 00
Principles of Elementary Mechanics.....	12mo,	1 25
Turbines.....	8vo,	2 50
The World's Columbian Exposition of 1893.....	4to,	1 00

## METALLURGY.

Egleston's Metallurgy of Silver, Gold, and Mercury:		
Vol. I.—Silver.....	8vo,	7 50
Vol. II.—Gold and Mercury.....	8vo,	7 50
** Iles's Lead-smelting. (Postage 9 cents additional.).....	12mo,	2 50
Keep's Cast Iron.....	8vo,	2 50
Kunhardt's Practice of Ore Dressing in Europe.....	8vo,	1 50
Le Chatelier's High-temperature Measurements. (Boudouard—Burgess.).....	12mo,	3 00
Metcalf's Steel. A Manual for Steel-users.....	12mo,	2 00
Smith's Materials of Machines.....	12mo,	1 00
Thurston's Materials of Engineering. In Three Parts.....	8vo,	8 00
Part II.—Iron and Steel.....	8vo,	3 50
Part III.—A Treatise on Brasses, Bronzes, and Other Alloys and their Constituents.....	8vo,	2 50
Ulke's Modern Electrolytic Copper Refining.....	8vo,	3 00

## MINERALOGY.

Barringer's Description of Minerals of Commercial Value. Oblong, morocco,	2 50
Boyd's Resources of Southwest Virginia.....	8vo, 3 00
Map of Southwest Virginia.....	Pocket-book form, 2 00
Brush's Manual of Determinative Mineralogy. (Penfield.).....	8vo, 4 00
Chester's Catalogue of Minerals.....	8vo, paper, 1 00
	Cloth, 1 25
Dictionary of the Names of Minerals.....	8vo, 3 50
Dana's System of Mineralogy.....	Large 8vo, half leather, 12 50
First Appendix to Dana's New "System of Mineralogy."....	Large 8vo, 1 00
Text-book of Mineralogy.....	8vo, 4 00
Minerals and How to Study Them.....	12mo, 1 50
Catalogue of American Localities of Minerals.....	Large 8vo, 1 00
Manual of Mineralogy and Petrography.....	12mo, 2 00
Douglas's Untechnical Addresses on Technical Subjects. ....	12mo, 1 00
Eakle's Mineral Tables.....	8vo, 1 25
Egleston's Catalogue of Minerals and Synonyms.....	8vo, 2 50
Hussak's The Determination of Rock-forming Minerals. (Smith.) Small	8vo, 2 00
Merrill's Non-metallic Minerals: Their Occurrence and Uses.....	8vo, 4 00
* Penfield's Notes on Determinative Mineralogy and Record of Mineral Tests.	8vo, paper, 0 50
Rosenbusch's Microscopical Physiography of the Rock-making Minerals. (Iddings.).....	8vo, 5 00
* Tillman's Text-book of Important Minerals and Docks.....	8vo, 2 00
Williams's Manual of Lithology.....	8vo, 3 00

## MINING.

Beard's Ventilation of Mines.....	12mo,	2 50
Boyd's Resources of Southwest Virginia.....	8vo,	3 00
Map of Southwest Virginia.....	Pocket-book form,	2 00
Douglas's Untechnical Addresses on Technical Subjects. ....	12mo,	1 00
* Drinker's Tunneling, Explosive Compounds, and Rock Drills.	4to, half morocco,	25 00
Eissler's Modern High Explosives.....	8vo,	4 00
Fowler's Sewage Works Analyses.....	12mo,	2 00
Goodyear's Coal-mines of the Western Coast of the United States.....	12mo,	2 50
Ihseng's Manual of Mining.....	8vo,	4 00
** Iles's Lead-smelting. (Postage 9c. additional.).....	12mo,	2 50
Kunhardt's Practice of Ore Dressing in Europe.....	8vo,	1 50
O'Driscoll's Notes on the Treatment of Gold Ores.....	8vo,	2 00
* Walke's Lectures on Explosives.....	8vo,	4 00
Wilson's Cyanide Processes.....	12mo,	1 50
Chlorination Process.....	12mo,	1 50

Wilson's Hydraulic and Placer Mining.....	12mo,	2 00
Treatise on Practical and Theoretical Mine Ventilation.....	12mo,	1 25

### SANITARY SCIENCE.

Folwell's Sewerage. (Designing, Construction, and Maintenance.).....	8vo,	3 00
Water-supply Engineering.....	8vo,	4 00
Fuertes's Water and Public Health.....	12mo,	1 50
Water-filtration Works.....	12mo,	2 50
Gerhard's Guide to Sanitary House-inspection.....	16mo,	1 00
Goodrich's Economical Disposal of Town's Refuse.....	Demy 8vo,	3 50
Hazen's Filtration of Public Water-supplies.....	8vo,	3 00
Leach's The Inspection and Analysis of Food with Special Reference to State Control.....	8vo,	7 50
Mason's Water-supply. (Considered Principally from a Sanitary Stand-point.) 3d Edition, Rewritten.....	8vo,	4 00
Examination of Water. (Chemical and Bacteriological.).....	12mo,	1 25
Merriman's Elements of Sanitary Engineering.....	8vo,	2 00
Ogden's Sewer Design.....	12mo,	2 00
Prescott and Winslow's Elements of Water Bacteriology, with Special Reference to Sanitary Water Analysis.....	12mo,	1 25
* Price's Handbook on Sanitation.....	12mo,	1 50
Richards's Cost of Food. A Study in Dietaries.....	12mo,	1 00
Cost of Living as Modified by Sanitary Science.....	12mo,	1 00
Richards and Woodman's Air, Water, and Food from a Sanitary Stand-point.....	8vo,	2 00
* Richards and Williams's The Dietary Computer.....	8vo,	1 50
Rideal's Sewage and Bacterial Purification of Sewage.....	8vo,	3 50
Turneure and Russell's Public Water-supplies.....	8vo,	5 00
Von Behring's Suppression of Tuberculosis. (Bolduan.).....	12mo,	1 00
Whipple's Microscopy of Drinking-water.....	8vo,	3 50
Woodhull's Notes and Military Hygiene.....	16mo,	1 50

### MISCELLANEOUS.

Emmons's Geological Guide-book of the Rocky Mountain Excursion of the International Congress of Geologists.....	Large 8vo,	1 50
Ferrel's Popular Treatise on the Winds.....	8vo,	4 00
Haines's American Railway Management.....	12mo,	2 50
Mott's Composition, Digestibility, and Nutritive Value of Food. Mounted chart.....		1 25
Fallacy of the Present Theory of Sound.....	16mo,	1 00
Ricketts's History of Rensselaer Polytechnic Institute, 1824-1894. Small 8vo,		3 00
Rostoski's Serum Diagnosis. (Bolduan.).....	12mo,	1 00
Rotherham's Emphasized New Testament.....	Large 8vo,	2 00
Steel's Treatise on the Diseases of the Dog.....	8vo,	3 50
Totten's Important Question in Metrology.....	8vo,	2 50
The World's Columbian Exposition of 1893.....	4to,	1 00
Von Behring's Suppression of Tuberculosis. (Bolduan.).....	12mo,	1 00
Worcester and Atkinson. Small Hospitals, Establishment and Maintenance, and Suggestions for Hospital Architecture, with Plans for a Small Hospital.....	12mo,	1 25

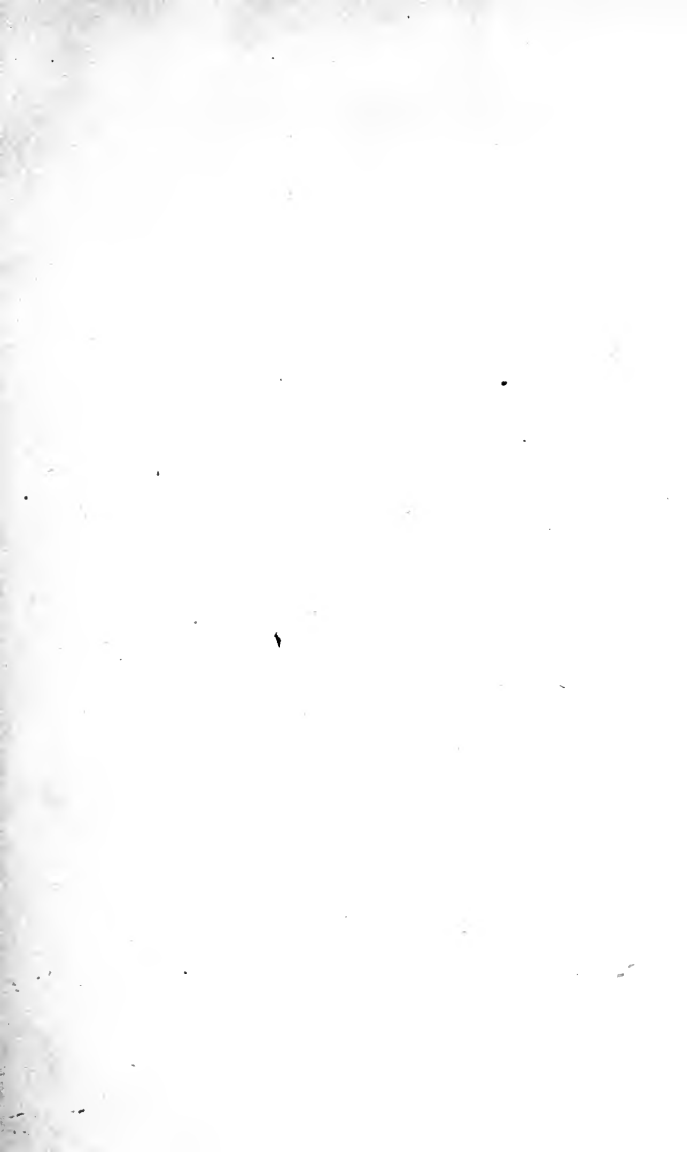
### HEBREW AND CHALDEE TEXT-BOOKS.

Green's Grammar of the Hebrew Language.....	8vo,	3 00
Elementary Hebrew Grammar.....	12mo,	1 25
Hebrew Chrestomathy.....	8vo,	2 00
Gesenius's Hebrew and Chaldee Lexicon to the Old Testament Scriptures. (Tregelles.).....	Small 4to, half morocco,	5 00
Letteris's Hebrew Bible.....	8vo,	2 25





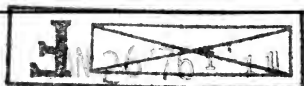




T  
371  
W75

THE LIBRARY  
UNIVERSITY OF CALIFORNIA  
Santa Barbara

THIS BOOK IS DUE ON THE LAST DATE  
STAMPED BELOW.



Series 9482



A 000 600 128 3

